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EVERYTHING PNEUMATIC.

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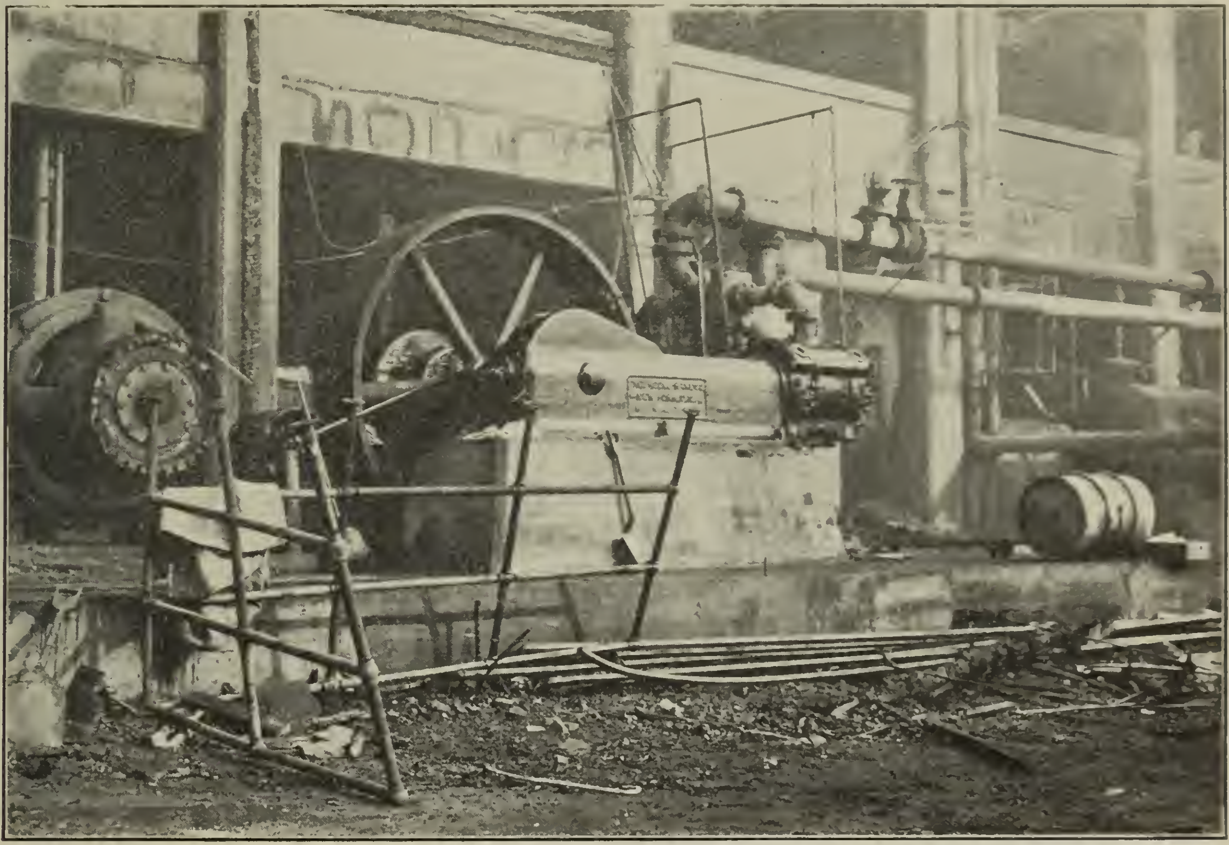


AIR COMPRESSOR AFTER THE EDISON FIRE.

A SPECIAL AIR COMPRESSOR IN THE EDISON FIRE

The photo here presented constitutes an unusually interesting souvenir of the fire which recently destroyed the works of the Edison Company (Thomas A. Edison, Inc.), at Orange, N. J. Although the destruction of the works was quite complete and the heat of the fire intense, as evidenced by the complete wreckage of the electric motor which drove the compressor—note the condition of the motor pulley—the compressor was scarcely injured at all.

This machine was installed in the Edison works less than two years ago, and it performed an important function in the manufacture of the Edison phonograph record cylinders. For such work as this it might have been expected that the machine would be required to be specially adapted to satisfy the peculiar conditions of working; and such was the fact.

The machine is an Imperial, belt driven (short belt drive) duplex, single-stage compressor with air cylinders 15 inches diameter by 16 inches stroke, and technically designated by the builders, the Ingersoll-Rand Company, as 15-in.x16-in., Type XB-I.

The intake of the compressor, however, was not from the atmosphere, as is indicated at once by the two large pipes leading off to the right from the compressing cylinders. The actual working pressure required in this case was about 95 lb. gage, and all the work was done with a fall of pressure of only about 10 lb., the air at the surviving pressure being connected back to the machine, and it therefore was only required to re-compress the air from 80 lb. to 100 lb., and so allow it to be used over and over again.

This arrangement suggested high economy to begin with, since to have continually compressed fresh air from the atmosphere, delivering it at 100 lb., would have required a compressor of five or six times the volumetric capacity, with two stage compression, intercooling and all that, with more than a proportional aggregate of power consumption. The using of the same air continuously also gave control of its condition as to humidity and temperature, which in this case was of great importance.

The imperative problem of controlling the volume of the compression under the varying conditions of the service, and with the motor running at constant speed was one of unusual complexity, but which was satisfactorily solved by the compressor builders. The air as compressed could not be used at a perfectly uniform rate, nor could it be returned with constant flow, the fluctuations of the two also not being always coincident. The arrangement adopted, which cannot be described in detail here, comprised an automatic unloader at the discharge with a run-around or by-pass to the intake. On account of the high pressure at the intake the cylinder and appurtenances were required to be stronger than for free air service. It will be seen that in various ways this is no ordinary compressor. Mr. Edison has set many inventive and constructive tasks for others besides those which he has set himself to solve.

Franklin S. Lane, Secretary of the Interior, estimates that over $10,000,000 worth of natural gas has been conserved the past year at an expenditure of but about $10,000. For the coming year an effort will be made to save $150,000,000 worth of gas and oil by an appropriation of $25,000.

THE ELECTRIC-AIR COAL MINE

BY CHARLES C. PHELPS.

Reviewing the history of coal mining from the time when mechanical methods of mining began to supersede hand work, we find that for a long time machinery operated by compressed air practically monopolized the field. In recent years, however, with electric energy at hand in many mines for such purposes as lighting, ventilating, pumping, hauling and hoisting, it was only natural that the attempt should have been made to design coal-cutting machinery to be driven by the same power.

Comparing electrically and pneumatically operated coal-cutting machinery, considerations of safety are on the side of the pneumatic machines. Electric feeder wires leading to a cutting machine are an ever-present source of danger to the workmen, especially in view of the darkness and cramped positions in which the miners often have to work.

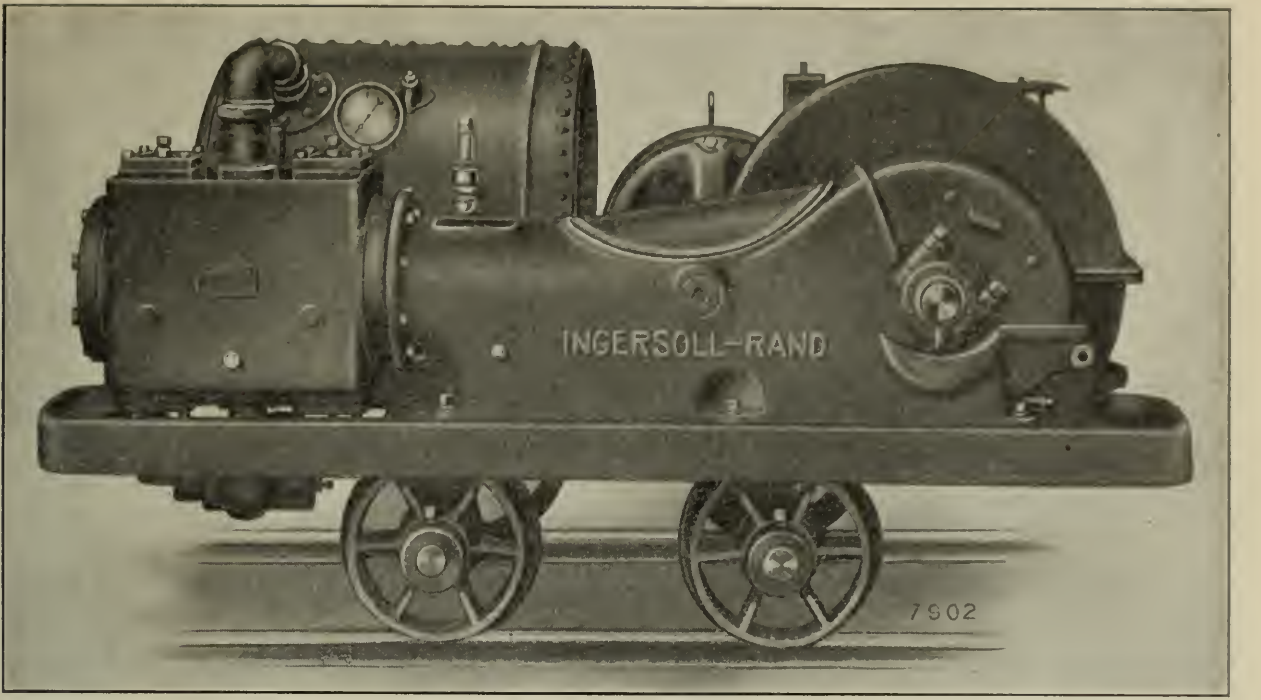
The danger of igniting mine gases is probably greatest near the freshly opened faces for two reasons: First, because of the insufficient ventilation often found in such locations, and second, due to the fact that the opening cuts frequently liberate pockets of gas. Pneumatic machines tend to eliminate the hazard from gas at the face by the added ventilation furnished by the exhaust air.

It is a well known fact that no type of machinery excels air-operated coal-mining machines in ruggedness of design and general reliability. The nature of the pneumatic action insures a cushioned blow which protects the machine to a large extent against injury. The pneumatic mechanism is simpler than the electrical, and consequently is better suited for rough and ready use in coal mines where operating conditions are never too favorable.

In order to utilize and secure the advantages of air power in mines already electrically equipped, additional air lines and compressors have to be provided. At present those mines which are using electrical mining machinery have found it profitable or expedient to do without the inherent advantages of pneumatic methods in order to secure those other advantages which can be obtained from the electrical power. It must be confessed that this procedure is a compromise rather than a solution.

A PRACTICAL SOLUTION FOR THE ELECTRIC MINE

The logical course to pursue in the electri-



MINE TRACK COMPRESSOR.

cally equipped coal mine is to find a means of securing the benefits of compressed-air machinery while at the same time utilizing all of the advantages of the electric system of distribution. This end is best attained by installing electrically operated air compressors in convenient places in various parts of the mine What is a convenient location today will become an inconvenient one in a week or a month, as the mining progresses from room to room. Consequently in an ideal system of power conversion for a coal mine, these local air plants should be portable units.

As a result of these conditions, which are peculiar to the electrified coal mine, operators have been calling for a practical electrically operated portable compressor plant. This demand has been met, and in Fig. 1 is illustrated an efficient compressor of this type.

The truck is built for any gage of track and can be run into any entry that will accommodate a mine car. The compressor may be placed in any convenient location in one of the main entries and connected to the cutting machines in one or more rooms by means of suitable hose.

These portable outfits are designed in every way to meet mine conditions. They are built for either direct or alternating current, and for any of the voltages commonly employed in coal mines. The compressor is suitable for pressures of from 50 to 100 lb., as desired.

The herringbone-gear drive is completely inclosed and runs in a bath of oil. The compressor proper is also of inclosed construction, and has a hopper type of water jacket, which is open to the atmosphere at the top. This type of jacket requires refilling but once a day, which is an advantage in a coal mine, where clean water is usually scarce and where the best attention is not to be expected. The latter idea was kept in mind in adopting the various features of design.

The lubrication is automatic. An inlet unloader maintains a constant air pressure in the receiver, which is mounted on the truck beside the compressor. The valves are of the new Ingersoll-Rogler type, which is a complete departure from previous compressor practice. These valves combine lightness, toughness, small spring tension and large free area, from which follow a high efficiency, great durability and remarkable quietness of operation.

An additional element of economy with the portable type of compressor is found in the fact that the air is used in its heated condition, obtaining the advantages of a reheater without actually employing this device. Of course, the full benefit of this heat is obtained only when using short air-feed lines, as the chilling of the air in passing through a long pipe is rapid.

RADIALAXE WORKING IN A COAL BAND.

THE ECONOMY OF THE EQUIPMENT

One of the first questions that the mine operator will ask is: "Are these portable outfits economical?"

Taking the case of a coal mine already equipped with electricity and desiring to operate a given number of pneumatic coal-mining machines, and comparing the two methods of air supply; i. e., from a motor-driven central air plant on the surface and from a number of small portable air compressors underground, the actual power consumption would undoubtedly be but little greater with the latter system, provided it were properly planned, assuming that both systems employed modern and efficient equipment.

The reasons for this are apparent. Although the motor and compressor efficiencies of the central plant would be higher than the combined efficiency of several small units, it must be borne in mind that the recent improvements embodied in the latter have given them a very fair efficiency. This difference in efficiency is largely compensated by the smaller leakage losses, lower pressure drops and reduced heat dissipation in transmitting the air over the shorter distances to the cutting machines.

It must be emphasized that the above discussion applies only to mines already equipped with electrical power. Of course, these portable equipments would not be advocated for use in a mine not electrified, for it would undoubtedly be much more economical to compress the air in a steam-driven compressor, using slack coal as fuel, and pipe it throughout the mine rather than to construct an electric plant exclusively for driving such portable units.

Other advantages of the portable type of air compressor for the electrified mine are the facility with which the machine may be moved about from place to place in minimum of time,

DRIVING GANGWAY
WM INGERSOLL RAND CO B.C.R #43 JACKHAMMER DRILL
STANTON VEIN HOLLENBACK COLLIERY
LEHIGH & WILKES-BARRE COAL CO

GANGWAY DRIVING WITH JACKHAMER DRILL.

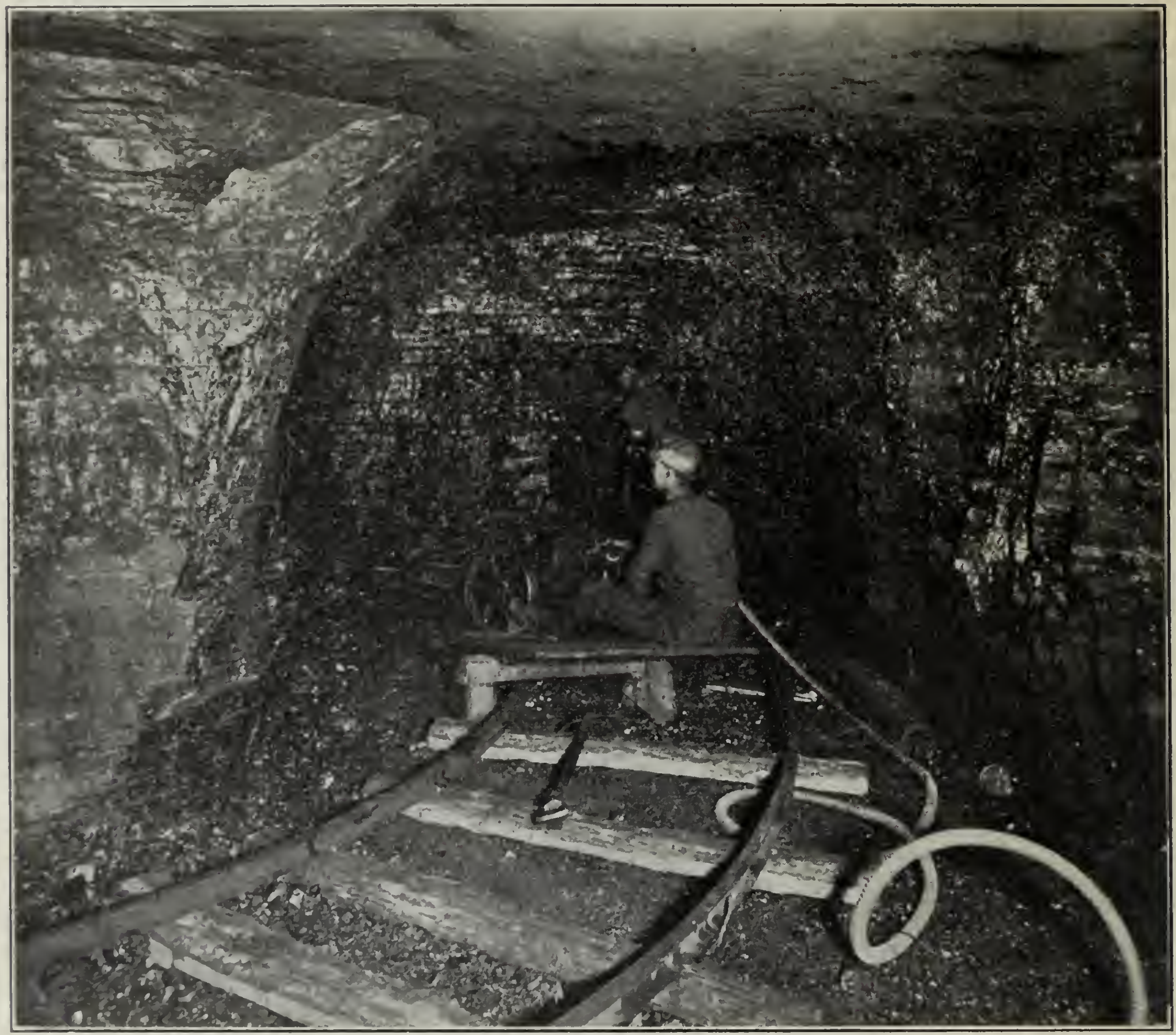
permitting air to be supplied to any room where needed without delay. Moreover, these equipments may be purchased only as needed, there being no necessity for maintaining a capacity in excess of the actual needs of the operation.

Now comes the question of the work capacity of these portable outfits. The following table gives the essential details concerning the various sizes of portable mine compressors already in use, as well as an approximate idea of the number of pneumatic coal-mining machines of different types that they will operate. The power cost will, as a matter of fact, figure out more favorably in actual practice in view of the fact that the service will always be intermittent rather than continuous.

An approximate idea of the capacity of these

PRINCIPAL DIMENSIONS OF PORTABLE MINE CAR ELECTRICALLY DRIVEN COMPRESSORS

Size of Cylinder, In.						Dimensions		
Dia.	Stroke	R.p.M.	Piston Displacement, Cu.Ft. per Min.	Air Pressure, Lb. per Sq.In.	Brake Horsepower	Length	Width	Height over Rails (Width 10-In. Wheels)
7	6	300	78	90–100	12–12.5	7′.	4′ 0″	3′ 2″
8	6	300	102	50–60	12–18	7′	4′ 0″	3′ 2″
9	8	250	145	90–100	23–24	8′ 3″	4′ 8″	3′ 10″
10	8	250	179	50–60	22.5–24.5	8′ 3″	4′ 8″	3′ 10″
12	10	235	304	90–100	51–53	9′ 4″	5′ 8″	4′ 4″
14	10	235	415	50–60	52–56	9′ 4″	5′ 8″	4′ 4″



COAL PUNCHER IN ILLINOIS MINE.

plants may be gained from the fact that the larger sizes can operate 3 coal punchers or 1 "radialaxe" machine, 6 to 8 jackhamers or from 8 to 12 "crown" coal picks.

The medium sizes will take care of one coal puncher, 2 to 4 jackhamers and 3 to 6 "crown" coal picks. The smaller sizes will furnish air to 1 or 2 jackhamers or 2 or 3 "crown" coal picks.—*Coal Age.*

In its natural state wood contains no sugar, but when sawdust has been subjected in close retorts to digestion with a weak sulphurous acid solution under pressure of six to seven atmospheres, a very remarkable transmutation takes place, as much as 25 per cent. of the material being converted into sugar. In this there is a valuable feeding stuff for horses, cattle and sheep.

Numerous advantages over pipes of other materials are claimed for the asphalt-paper pipes that are being introduced in Austria. The makers assert they can replace iron, steel, copper and clay piping for all purposes except the conveyance of hot fluids, concentrated acids, and petroleum. The pipes are made from a special kind of asphalt paper of German manufacture.

The Yale "Bowl" has a playing arena 300 by 500 feet, outside dimensions 750 by 950 feet, a seating capacity of 61,000 and no standing room. The dimensions of the Colosseum at Rome were: arena, 177 by 281 feet, seating capacity, 50,000. The dimensions of the structure at Pompeii, which the Bowl most nearly resembles, were, 115 by 218 feet and 342 by 444 feet, seating capacity, 20,000.

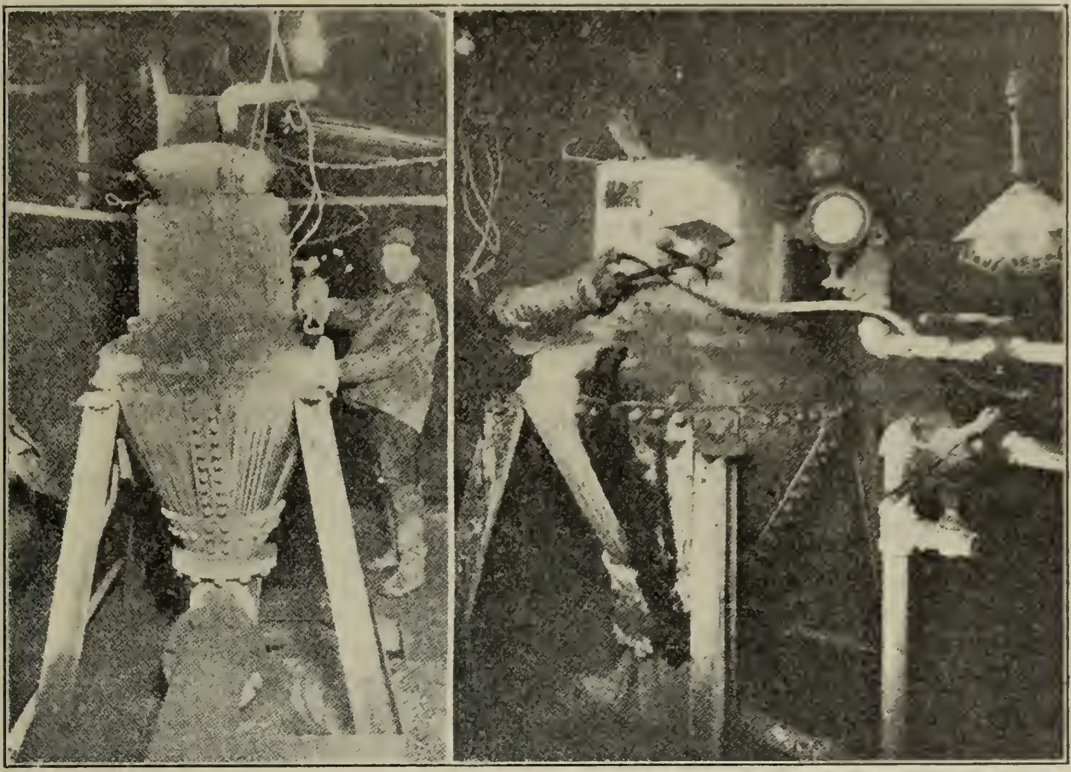


FIG. 1.

RECORDS OF OPERATION IN HANDLING CONCRETE WITH COMPRESSED AIR

The following is an abstract of a considerably longer article in a recent issue of Concrete-Cement Age. The topic treated is not new, but the details of operations are interesting and valuable. The information embodied was furnished by H. B. Kirkland, President of the Concrete Mixing and Placing Company, Chicago.

At present there are a great number of plants, working at different localities all over the country, successfully placing concrete through pipes with compressed air. This method is now well established on a commercial basis, there having been in operation for the last three years machines which handle aggregate of large size and mix and place concrete at the rate of from 15 cu. yds. to 40 cu. yds. per hr.

The use of a pipe line takes the place of all the men used to haul, hoist and transport concrete, and eliminates the necessity of such plant as towers, runways, dinkey engines, track, trestle, cars and other plant ordinarily required for conveying concrete.

Tests on concrete made in this manner show results that are at least as high as concrete made in the ordinary manner.

DESCRIPTION OF PNEUMATIC MIXER AND CONVEYER.

The mixer, shown in Fig. 1, consists essentially of an inverted boiler plate cone, standing vertically, having an air-tight door at the top for the admission of materials, with a cast steel elbow at the bottom through which the concrete is discharged to the conveyer pipe. The door is operated by a small pneumatic piston, and nozzles are provided for the admission of air into the top of the cone and into the elbow at the bottom of the mixer.

An 8-in. pipe of No. 10-ga. metal or an 8-in. well casing is ordinarily used for conveying the concrete. A heavy steel pipe may be economical where large quantities of concrete are to be placed without any changes in moving of the pipe line. The facility with which the delivery pipe can be carried under, over, or around obstructions which would make wheeling difficult is one of the important advantages of the system.

METHOD OF OPERATION.

The operation of the mixer is very simple. The sand, stone, cement and water in the proper proportions are fed into the mixer through the hopper and the door is closed by the small air cylinder shown. The compressed air is then turned on, entering the mixer at two points, one above the charge, and one at the heel of the elbow. The batch is forced through the pipe to the forms, it being mixed as it leaves the mixer and in the first few feet of pipe. The concrete is thus mixed with the same air which is used to convey it through the pipe. In this way the concrete is mixed and placed without labor and with no other equipment than pipe for transporting the concrete. Within 10 sec. after water has been added to the cement, the concrete is in the forms at rest. It is all done in one operation.

The amount of air required for operating the machine depends upon the length of the delivery pipe. This will vary also with the number of turns in the pipe line, with the kind of material used for aggregate and with the vertical distance involved in the delivery. It is demonstrated, however, that for general purposes of calculation, the amount of air will not exceed 1 cu. ft. of free air compressed to 80 lbs. pressure for each lin. ft. of 8-in. delivery pipe for each batch of concrete.

An air storage tank is usually placed close to the machine, the capacity of this tank being large enough to store sufficient air at 80 lbs. pressure to discharge one load, which means 1 cu. ft. of space for each 6′ of pipe line. For general concreting work a compressor of 600 cu. ft. per min. capacity is said to be the best size, although a 300-cu. ft. machine would be large enough to use with a ¼-yd. mixer and 300 ft. of pipe.

When the proper size of stone is used, there is little likelihood of clogging occurring, provided the machine is not operated with an air pressure very much below the 80 lbs. required for successfully carrying the concrete to the full distance.

Wherever it is desirable, a box may be used to receive the concrete as it is discharged from the pipe, from which it can be allowed to run out by gravity into the forms.

OUTPUT OF MACHINE.

The output of the machine is dependent upon the speed of loading. The mixers are made in ¼-yd. and ½-yd. sizes and the speed of loading varies between 60 batches and 120 batches per hr. The provision of overhead bins makes possible the higher rates of loading which would give the ¼-yd. machine a capacity of 30 cu. yds. per hr., and the ½-yd. machine 60 cu. yds.

APPLICATION IN GENERAL.

Work in which the pneumatic method had already been used to advantage comprises bridge construction, tunnel lining, retaining wall construction, heavy foundations and piers, as it is not required that the mixer be located above the point of deposit as is usually the case with plants distributing by gravity systems. That is to say, the concrete plant can be located lower than the place of deposit and the pipe can be run along the line of the work at any level with vertical pipes placed to raise the material to the points of deposit. This puts the concreting equipment entirely out of the way of the other construction plant and makes it possible to do concrete work without monopolizing the cableway or the derricks.

FOR LINING TUNNELS.

The machine is well adapted to tunnel lining, as it enables the arch to be placed as rapidly as the side walls. Sections of tunnel 25 to 40 ft. in length may be filled by entering the pipe through the form at the top, or in large tunnels at both top and haunches.

In small tunnels where the shafts are great distances apart the machine is taken into the tunnel and sunk, by blasting out a place for it, so that the top of the machine is low enough for the narrow gage cars to dump into it. In this way a tunnel of any length may be concreted by using pipe about 500 ft. long and moving the machine back for each 500 ft. section.

CAR FOR LINING LARGE RAILROAD TUNNELS.

Figs. 2 and 3 give an idea of the equipment used by the C. B. and Q. R. R. for lining the 1000 ft. Alkali Summit tunnel, where the concrete has to be placed without disturbing the traffic. The pneumatic mixer and conveyer, previously described, is mounted on a standard 40 ft. flat car, with material bins, cement storage, a water tank and a delivering pipe leading from the mixer out above the car. Both bins slope toward the mixer placed in the center of the car, where they discharge through chutes into a measuring hopper.

This hopper is lifted and tilted to discharge into the mixer by means of a cable operated by a small air cylinder. Air to operate this cylinder and to supply a large receiver operating the mixer is obtained from the compressed air main laid on the track the full length of the tunnel, connection being made to the car at any point. Water also is sup-

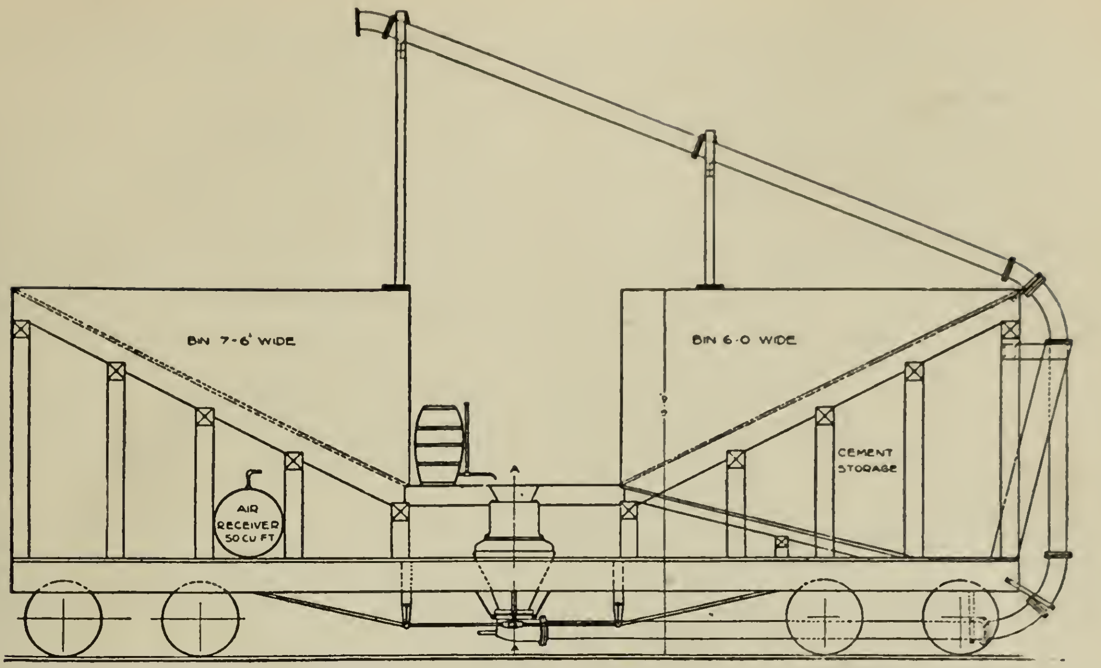


FIG. 2.

plied from a line paralleling the air line. The bins, holding material enough for 25 cu. yd. of concrete, are loaded and the car is run into the tunnel and connected to the air line.

The 8-in. pipe which conveys the concrete from the mixer to the tunnel forms, runs from the mixer under the car, up at the end to the top of the bins, 14 ft. above the rail, and thence on an incline to a point 24 ft. above the rail, where it enters through a bulkhead of the tunnel form, a slot being left to shift the end of the pipe slightly, depending upon which wall of the tunnel it is desired to fill. This inclined pipe is raised and lowered between wooden guides by a cable attached to an air-cylinder. The guides may then be folded down out of the way, giving 16 ft. of head room for braces. Fig. 3 shows an end view of the car with the conveying pipe folded down so that the car can be moved.

The mixing and placing of 25 cu. yd. of concrete takes 1 hr., and the operating crew consists of four men: One who operates the mixer and all the valves, one to carry cement, one to untie the cement bags and dump the cement into the hopper and one to operate the gates for filling the measuring hopper with aggregate. The air pressure used to operate the mixer and conveyor is 80 lb. For retaining wall work the pipe is usually carried from the mixer up over the top of the forms with a right angle at the end for discharging directly down into the forms.

VARIOUS TYPICAL JOBS.

One of the first tunnels upon which this machine was used was the La Salle St. tunnel, Chicago, where the machine was set up on the bank of the river and the pipe extended from the machine down a shaft 35 ft. deep and

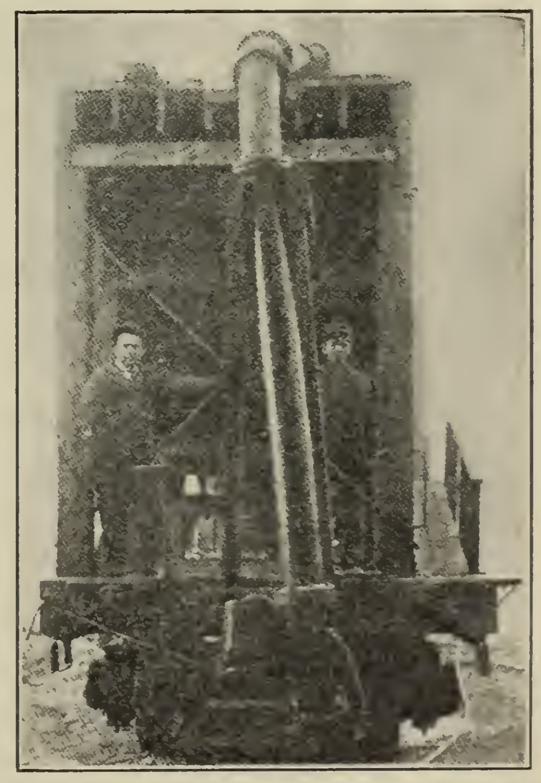


FIG. 3.

then horizontally about 300 ft. Later, on the O. K. Creek sewer tunnel, Kansas City, the machine was placed at the bottom of the shaft and the materials for the concrete were dumped into the machine through a chute from the top of the shaft.

The Otis Steel Company recently used a ½-yd. machine at Cleveland, for placing the piers for its new plant. [This was described and illustrated in Compressed Air Magazine, June, 1914.] There were about 300 piers of various heights, the materials totaling about 25,000 cu. yd. The machine was located at one side of the lot with its top flush with the ground and a bin with a capacity of 80 cu. yd of crushed slag and 30 cu. yd. of sand was built over it. Ample means for conveying and distributing without hand work were provided. The necessary air at 80 lb. was furnished by an Ingersoll-Rand electric driven compressor. The average daily speed was one batch per min., or 15 cu. yd. per hour.

On outside mass concrete construction the work at the Ontario Power Company's plant, Niagara Falls, Ontario, Sept., 1913, illustrates a great economy. On a portion of this work there were three separate retaining walls, one 20 ft. below the level of the mixer and about 100 ft. to the east. The two other walls were at an elevation of 30 feet above the mixer and 80 ft. to the east. The plant required one foreman and 10 laborers to charge the mixer; three men to operate it and one foreman and four men to spread the concrete in the forms. During the time required to change the pipe, the charging gang was used in excavating, so that a portion of their time was not chargeable to the cost of placing the concrete. The labor cost per hr. was $4.80, and, charging the actual time used in placing 257 cu. yds., the cost amounted to $77.35, or 30 cents per cu. yd.

One of the most important jobs yet undertaken under this system is the lining of St. Louis waterworks tunnel. This tunnel is 8 ft. in diameter with a concrete lining 9 in. to 18 in. thick; it is not reinforced and is located in solid limestone. The tunnel is about 2,900 ft. long and has a shaft on the bank of the Mississippi river, which is about 550 ft. from the west end of the tunnel and about 2,200 ft. from the east end, which is under the Mississippi. The land section of the tunnel was concreted first and the concreting was practically all done in the month of May, 1914, doing but two arch sections, 36 ft. each, in April. The grade of the tunnel from the shaft west is + 6 per cent.

The mixer was set at the bottom of the shaft, which is 96 ft. deep, and was loaded from the top by dropping the material for each batch through an 8-in. pipe directly into the mixer. At the top the batch was measured by means of a measuring hopper in which the batch was placed. At a signal from the machine operator below, the sliding door of the hopper was opened, which allowed the batch to drop into the mixer through the pipe. Water was dropped at the same time through a 2-in. pipe which led to the mixer and which was supplied from a water barrel controlled by the man operating the hopper gate.

As soon as the batch was dropped into the mixer the operator closed the door into the machine which was operated by a small air valve and turned on the air which mixed and discharged the concrete through an 8-in. pipe into the forms.

The forms are 36 ft. in length and the pipe carrying the concrete is laid along the bottom of the tunnel to within 20 ft. below the forms and then by means of two 22½ degree elbows and one section of pipe 20 ft. long, the pipe enters through the top of the forms through a bulkhead. The section of pipe 18 ft. to 20 ft. long is put over the top of a 36-ft. form and the concrete is discharged through this until half of the form is poured. The concrete is discharged back against the completed concrete work and flows around the form, assuming the slope of about 30 degrees. When the arch is filled to within 1 ft. or so of the end of the pipe the end piece of pipe is removed so that the balance of the form is filled by discharging concrete from the end of the pipe just entering through the bulkhead.

Sand bags are employed for bulkheads instead of employing carpenters constantly to patch up the irregular places. The bulkhead, which consists of a 9 in. board bolted to the center and sand bags, is laid against the board projecting beyond the board into the irregularities of the rock. While the concrete work is going on the bags are laid by a man who watches the progress of the concreting. He can see under the forms and determine whether or not the concrete is filling equally on both sides of the form and if it is not he can spring the pipe over to one side or the other to keep the load balanced. The concrete is usually brought to within 1 ft. of the end of the pipe and then if desired this small pocket may be filled by discharging a very small batch through the mixer, or it may be filled by hand in case the last batch has spilled enough concrete over. The usual practice, however, is to leave the concrete about 1 ft. from the pipe and to move the forms just sufficiently to take in this cavity in the next pouring.

The Fruin-Colnon Contracting Co., St. Louis, is the general contractor on the construction of the new tunnel and the intake tower.

THE NEWEST ROCK DRILLING PRACTICE

The following we take from an elaborate article by Mr. F. Lavis, in *Engineering News*, Dec. 3, 1914, describing construction operations on the New York Rapid Transit extensions.

One feature of considerable interest, is the quite extensive use of the so called Jap or hand hammer drill with hollow drill steel. The New York rock, a soft to medium hard gneiss or mica schist, seems to lend itself particularly well to the operation of this kind of drill in excavations where most of the holes are down holes. The type which is in most general use, is the Ingersoll-Rand B.C.R. 33, which weighs about 90 lb., using air at 80 to 90 lb. pressure. The hollow drill steel is usually about 1⅛ in. octagon, the holes are drilled dry, the air through the steel blowing out most of the dust, therefore keeping the holes clean and consequently increasing the effectiveness of the machines. These drills are used for drilling holes to depths up to 12 and 14 ft.; it is stated that they require from 50 to 75% less air at the same pressure than the usual tripod drill does, and only one man is required to operate each of them. The general opinion seems to be that unskilled laborers with very little instruction could use these drills, though, of course, in New York the labor unions compel the employment of regular union drill runners.

On Section 14 (McMullen & Hoff) four men with as many drills were averaging from 80 to 90 ft. of hole per man per day of eight hours. There was one record of 113 ft. for one man in eight hours. It was considered advisable to keep a number of spare drills on hand, so that in case anything went wrong, there was no delay, and any damaged drill could be taken to the shops, where it could be carefully repaired by a competent machinist, even though the trouble was very slight. This was considered to be better than to have an ordinary drill runner try to fix it with the spanner or sledge hammer, the tools usually used by them when anything is wrong with a drill. These drills were also used on the heavy rock excavation of Section 13, a cut 30 to 50 ft. wide and as many feet deep, with excellent results.

On some sections a lighter type of drill weighing about 40 lb. and using about 50 ft. of air per min. is being used; this is the B.C.R. No. 430 or so called Jackhamer type, used for holes up to 6 and 8 ft. in depth using ⅞-in. hollow steel.

Another point of interest is the almost universal use of machine drill sharpeners, nearly all of which are of the Leyner type. This use of machine sharpeners is possibly due, to some extent, to the use of the hollow steel and the rose-shape form of bit generaly used with these hand drills, though of course, it has been shown even with the old type of cross bit, that where the number of drills warranted, the installation of a drill sharpener was an economy.

It is stated by the contractors on Sec. 13 and 14 that the general breakage and wastage of steel used is rather greater than with the ordinary steel, and, of course, the hollow steel is more expensive, but it is thought this is much more than compensated by the greater amount of work done. The Leyner drill sharpeners are used to make all the bolts for the timbering on one section, where it was stated that 400 bolts were headed per hour.

Electric current is used for power at most of the compressor plants, and air is usually piped to all points of the work for use in drills, pneumatic riveters, etc. In some cases the air is used for operating hoists and derricks, in other cases electric power is used directly for this purpose; this apparently is governed most generally by the plant the contractor may have had on hand, but the use of air for hoists and derricks, so long as it has to be installed in any event, seems to be the most satisfactory and most generally used.

REHEATING COMPRESSED AIR

Various schemes for heating the air during cold weather were noted, some of the apparatus home-made and other manufactured especially for the purpose. On one section (McMullen, Snare & Triest) an upright coil of about 6 to 8 rings, 15 to 18 inches in diameter, was made in the air line near the point where it was to be used, and a fire built and maintained inside the coil. In another case a piece of 6- or 8-in. pipe about 3 ft. long was capped at the ends to take the regular air line (about 2 in.) and a fire built under the larger section. These home-made schemes are probably somewhat wasteful of fuel, but this amounts to very little and they probably stand up better under the rough usage they get on this kind of work, than the manufactued heaters.

RECORD OF ELECTRIC-AIR DRILLS ON THE MESABI RANGE

For five months, during 1913-14, some interesting drilling was done at the Virginia mine on the Mesabi range, under the direction of J. H. Eby, at that time superintendent. The machines used were Type 5-F Temple-Ingersoll drills, on tripods. It may be well to recall here that these drills employ both air and electricity in their operation, but not in the manner of some other electric air drills. The air is not used once and exhausted, but constitutes the manner of transmitting the electric power. The air circuit is a closed one, the air being returned for use again, excepting that small portion that escapes through leakage. The drill is connected to a separate carriage, holding the pulsator and motor, by two lines of air hose, acting as the supply and return lines.

At the Virginia mine the drills were operated on a 220-volt three-phase alternating current. They were manned by a runner, at $3 per day, and two helpers at $2.40 per day each. All the holes drilled were over 10 ft. deep and the majority over 24 ft. deep. Some of the holes were vertical and some were as flat as 5 degrees from the horizontal. Incidentally, according to Mr. Eby, experience proved that cruciform steel was best adapted to the work, the great difficulty being in keeping the holes clear of sludge. The material drilled varied from soft hematite to extremely hard taconite. In the latter rock, three hand drillers, two striking and one turning, with an ample supply of sharp steel could drill not over 1 ft. per hr. Fissured ground was common, and the ore was exceedingly irregular, with hard seams in the soft ore. The softest ground was the most difficult to drill because of fissuring and caving.

The following tables show the data obtained from five months' operation:

TABLE 1—HOLES DRILLED

Number	848
	Feet
Solid taconite	826
Fissured taconite	402
Hard ore, solid	2346
Hard ore, fissured	518
Soft ore, solid	3875
Soft ore, fissured	1130
Total	9097

TABLE 2—TIME DRILLING

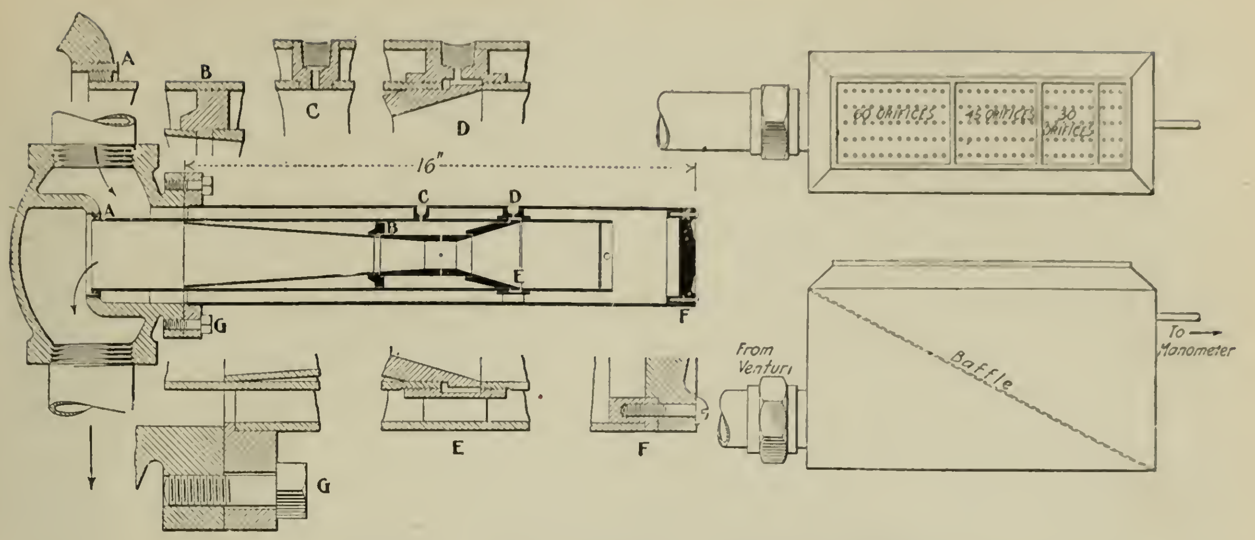
	Hours
Machines in place	1465
Delays, long moves	39
Power off	140½
Dull steel	11½
Bad order of machines	56
Net working time	1218

TABLE 3—COSTS

Labor	$1183.75
Repairs	25.00
Power	68.10
Total	$1276.83

Cost per foot, 14c.

The cost of drilling the same footage by hand on company account would have been 29c. per ft. This figure was obtained from four years' costs of the same class of work and covering the same amount of each class of material, but not taking into account the flat holes that could not be drilled by hand. These costs indicate a saving of 15c. per ft. by the use of this drill. Mr. Eby makes the interesting statement that it requires as much skill, if not a little more, to operate and properly handle this drill as it does any other. The costs given above include all the troubles incident to securing competent crews to handle the machines, and he believes that if operated regularly as efficiently as these were during the last month of work, the cost per foot could be reduced still further, perhaps to as low as 11 cents.—*Eng. and Min. Journal.*



APPARATUS FOR CALIBRATING VENTURI METERS.

CALIBRATING VENTURI METERS FOR AIR FLOW

In the design of the Brooklyn Sewage Experiment Station under Geo. T. Hammond, Engineer of Sewer Design, Bureau of Sewers, Brooklyn, N. Y., one of the troublesome problems was in securing a meter for the compressed-air lines. On account of the quantity of air used and the pressure, no form of available gas meter was found to meet the requirements. Therefore, special Venturi meters were designed jointly by Mr. Hammond and Wallace & Tiernan, of New York City. Interest attaches first to the method of calibration, and only somewhat less to the details of the meters.

CALIBRATION

The calibration method is of unusual interest and wide application. On account of the quantity of air flowing, it was impractical to use a gasometer for calibrating the meter. Therefore, a special multiple-orifice box was built to receive and measure the air passing through the meter. The top of the box was a metal plate having, in all, 150 orifices of the same size (made with the same punch) equally spaced. This top plate had a cover so arranged that any number of orifices from 1 to 150 might be left open. The orifices were designed to discharge 1 cu. ft. per min., under a head of 10 in. water pressure. A perforated metal screen, placed diagonally across the box, prevented eddy currents. Preliminary readings were made with a small gasometer to determine the air flows from different orifices (for rating the calibration box) and from different groups of orifices to see if there was any variation because of location or number of those discharging. It was found that the flows agreed within 1/5%.

In calibrating a meter, the box was connected to the air line through the meter and a certain number of orifices were uncovered on the top of the box, a stop valve being opened until the desired head was shown on the box manometer. Knowing the discharge for this number of orifices and the corresponding pressure, it was a simple matter to mark on the Venturi-manometer scale the flow corresponding to the height of liquid. The scale was then fully graduated in cubic feet per minute after having determined several of these points.

VENTURI METERS

The specifications, according to which the Venturis were made, called for three sets of meters; one reading from 20 to 150 cu. ft. per min., one from 5 to 20 cu. ft., and a third from 1 to 30—all operating under a pressure of about 40 lb. per sq. in. In order to secure the desired range with accuracy a type was designed with interchangeable throats. To secure accuracy through the range indicated, five meters would ordinarily be employed. Such multiplicity was ingeniously obviated in this case. The meters were assembled in tubes of the same size so that any one could be screwed into the body of an ordinary 3-in. check valve put in the air line. There were three barrels complete, with Venturi throats, etc., for each meter. Two of these three barrels were of small capacity and each had interchangeable throats, while the third was larger and had but one throat.

Air passes from the check valve (following the arrow in the upper left of the section of the meter shown in the accompanying drawing) along the meter barrel, through the throat and out through the air line again. To put in a larger or smaller throat giving the desired capacity, the barrel cap is removed, the approach tube screwed out of its bushing, and the throat approach and throat taken out. Without displacing further parts, the smaller or larger throat is inserted. All parts were made of brass and bronze.

The manometer intended for use with these Venturis was of special design. The cross-section of the oil reservoir was made many times greater than that of the manometer tube, so that the zero point was practically unaffected through the range of the scale. The upper end of the manometer tube, which was connected to the Venturi throat chamber, had a reservoir interposed of capacity slightly greater than that of the lower reservoir. This was done to prevent blowing any of the oil into the pipe line by sudden rushes of air. It may be added that these meters are used to measure compressed air supplied in experiments on the aëration of sewage.—*Eng. News.*

BEHAVIOR OF EXPLOSIVE MIXTURES OF GAS AND AIR*

An explosion is essentially a very rapid combustion which ocurs almost simultaneously in all parts of a mass of combustible substance. The heat developed by the combustion raises the gaseous products of combustion to a very high temperature, and gives them the enormous pressure and expansive tendency which produce the destructive effects of explosives.

In order that combustion shall be almost instantly propagated throughout a mass of gas it is necessary that the air required for combustion shall be intimately mixed with the combustible gas, and in order to attain the high temperature requisite for explosion the mixture must not contain a large quantity of gas that takes no part in the combustion, for such a mass of inert gas would exert a cooling effect. This consideration leads to the law, which is confirmed by experience, that mixtures of combustible gas with air are explosive only when the percentage of combustible gas in the mixture lies between certain limits. These limits, for some important gases and vapors, are given in the following table:

	Percentage of Gas in Explosive Mixture.	
Gas or Vapor.	Upper Limit.	Lower Limit.
Hydrogen	66.4	9.45
Illuminating gas	19.1	7.9
Methane (marsh gas) . .	12.8	6.1
Alcohol vapor	13.65	3.95
Ether vapor	7.7	2.75
Benzine vapor	4.9	2.4

The explosive limits, however, are dependent to some extent upon the size and shape of the containing vessel and upon the character of the ignition (strong electric spark, weak spark, or flame).

It will be observed that the proportion of combustible gas required to form an explosive mixture with air is very small, except in the case of hydrogen. Explosion may be caused by the presence of less than 3 per cent. of ether or benzine vapor in the atmosphere. In general, however, the danger of explosion is proportional to the range of explosiveness, i. e., the difference between the upper and lower explosive limits, and is consequently greatest in the case of hydrogen.

The danger of explosion can obviously be averted by preventing the mingling of the combustible gas with air.

FIG. I.

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*Scientific American translation from article by Victor Rodt in *Die Umschau.*

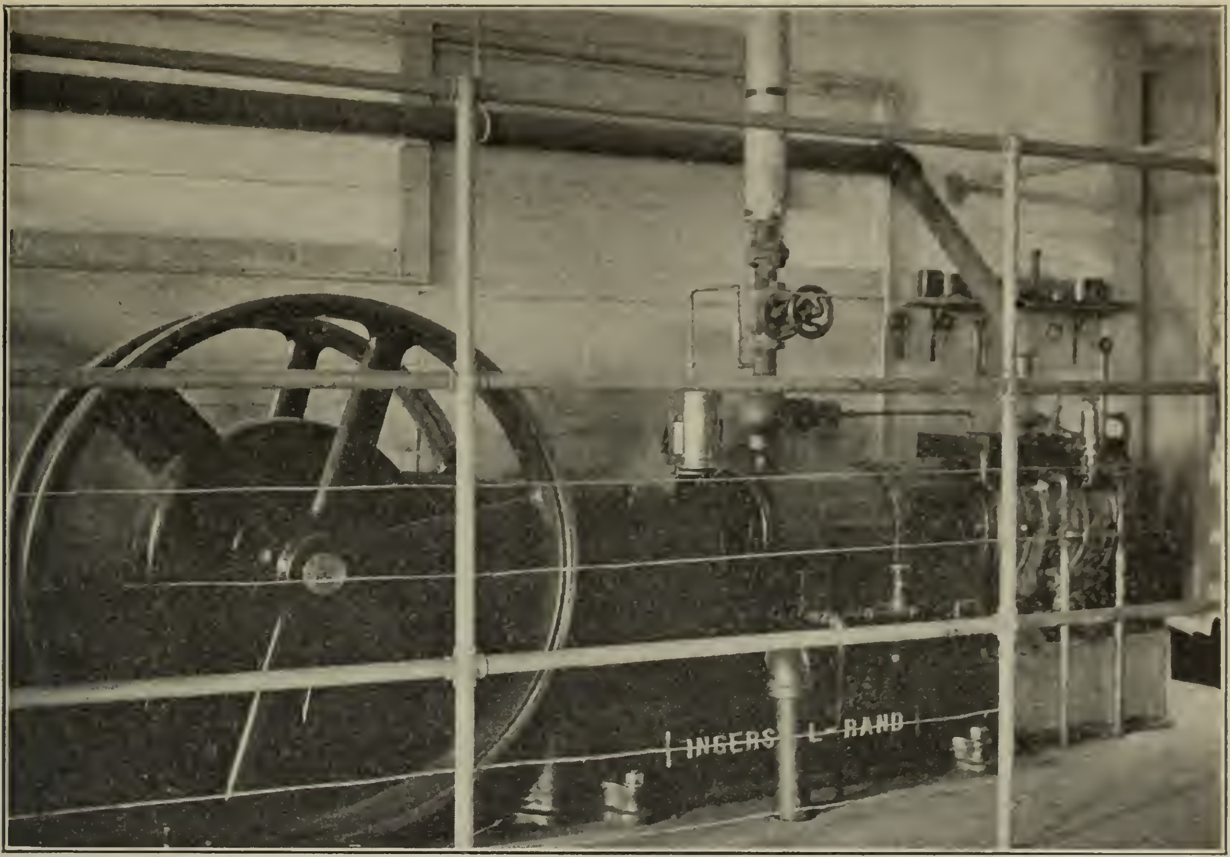


FIG. 2.

BRUSHING VS. BLOWING

BY CHARLES C. PHELPS

Hat makers find air jets superior to brushes for "raising the nap" on certain kinds of material, such as velours, beaver, clip beaver and imitation velours. After the hat has been formed in presses it is "ironed" by passing a hot damp cloth pad over it. The final operation is for the purpose of raising the hairs or fibres and imparting to the hat a fluffy appearance. Formerly brushes were used for this purpose, but they were slower and not so effective as the blowing method. Further, the air jet assists in rapidly driving out any remaining moisture, thus eliminating any danger of matting the fibres when packing the hats for shipment. The hat is rotated on a revolving form while the air jet is directed against it from a distance of a few inches. (Fig. 1).

The commonest form of nozzle used by hat manufacturers has a tip with a flat opening ½ inch in length and 1-16 inch or less in width. There is a self-closing valve close to this nozzle, so that there is no waste of air when the pressure of the thumb is removed from the button which controls the flow.

In the factory in which Figure 1 was photographed a ⅜ inch wire-wound air feed pipe was employed and the pressure maintained in the air line was 80 pounds per square inch. A large number of these jets were employed, in fact the demand for air was much in excess of the rated capacity of the compressor supplying this air, Fig. 2. As a result, the compressor was run under an overload a great part of the time and naturally the valve bonnets, which were the only parts not cooled by the water jacket, became excessively hot. This accounts for the wooden receptacle on top of the air cylinder, on the right hand end of the machine, which was improvised by the engineer to keep the valves cool with the aid of a water bath.

The photographs were taken in the hat factory of Wm. Knowlton & Sons, West Upton, Mass.

The annual meeting of the Compressed Gas Manufacturers' Association, Inc., will take place Monday, January 18, 1915, 2.30 o'clock p. m., at 25 Madison avenue, New York City.

GAS ENGINE HORSEPOWER AT DIFFERENT ALTITUDES

It has been the writer's experience that many students, and in many cases men who have had considerable gas engine experience, have the idea that the power of a gas engine increases as the altitude increases. They figure that at the higher altitudes the engine exhausts against less back pressure, and therefore its power is increased.

Although the engine is exhausting against back pressure, it is this same atmospheric pressure that supplies the engine with its mixture of fuel and air. If the pressure that supplies the cylinder with the mixture is reduced, the compression is reduced because the actual amount of mixture forced into the cylinder is less. As a result, the mean effective pressure is less and, therefore, of course, the actual output is less.

The decrease of power is in direct proportion to the decrease in atmospheric pressure. So if the altitude is known the barometric pressure in inches of mercury or the pressure in pounds per square inch can be obtained. Then a simple calculation will give the horsepower at that altitude. As a formula, it is as follows:

$$H_2 = H_1 \frac{P_2}{P_1}$$

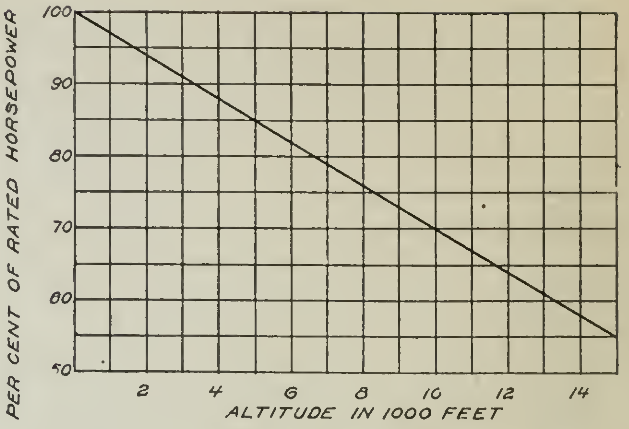
Horsepower at given altitude (H_2)=horsepower at sea level (H_1) times ratio of atmospheric pressure at given altitude (P_2) to atmospheric pressure at sea level (P_1, 14.7 lb. per sq. in., or 29.9 in. of mercury.)

Approximately the atmospheric pressure decreases 0.5 lb. per 1000 ft. elevation. This is close enough to give a good idea what the engine will deliver at the required altitude. The following tables gives the atmospheric pressure at various altitudes up to 2 mi.

Alt., mi.......	0	¼	½	¾	1	1¼	1½	2
Atmos. Pres., lb.	14.7	14	13.3	12.7	12	11.4	10.9	9.8

A more rapid and convenient method of calculating the horsepower at various altitudes is by a power curve, such as the one shown. This power curve will give results that are very accurate.

The following problem will serve to illustrate the methods of determining the horsepower. Problem: Required the power a 250-hp. gas engine will develop at an altitude of 1½ mi. above sea level when using the same fuel as that which gives the engine the 250-hp. sea level rating.



GAS ENGINE POWER AT DIFFERENT ALTITUDES.

At an elevation of 1½ mi. the atmospheric pressure is 10.9 lb. per sq. in. Now substituting in the formula:

$$\text{Power} = 250 \times (10.9 \div 14.7) = 185.3 \text{ hp.}$$

An altitude of 1½ mi. is practically 8000 ft. On the diagram, the power curve crosses the 8000 ft. altitude line at practically the 75 per cent. horizontal line. So the engine at 8000 ft. should develop 75 per cent. of its rated sea level power or 0.75×250=187.5 hp.—*Practical Engineer.*

CARE OF DRILL STEELS AN IMPORTANT FACTOR IN MINE EFFICIENCY

The following is an abstract of a portion of an article by Thomas M. Bains, Jr., in Mining and Scientific Press of San Francisco.

In too many mines sufficient attention has not been given to the systematic handling of the drill steel. With adequate steel, properly sharpened and heat treated, a machine man can drill twice the depth of hole that the same man under similar conditions can with too few drills or with plenty of steel which has been subjected to improper heat treatment. The process of sharpening and gaging has been worked out mechanically, by means of drill-sharpening machines.

SUFFICIENT STEEL AT EACH WORKING FACE

The purchase of sufficient steel and turning it over to the blacksmith does not mean that sufficient steel will be at each working face. In cases where contractors and company men work in the same mine, the contractors will 'corner' the steel and the company men will be short. Few mines in this country seem able to get steel to the machine men so that they will have a sufficient supply. It is generally left for each 'shifter' to secure steel for his shift or else each individual must 'rustle' his own steel.

In one of the largest of the Eastern mines, the steel was lowered down the shaft to the station once each shift. The machine men or helpers waited for it like a pack of wolves. Before the cage was within two feet of the level of the station, a rush like a football scrimmage took place. Men with seven or eight 'starters' would exultantly dash away from the cage, while others secured all long drills. Some would not secure any at all. In one case, two men had a four-foot and two six-foot drills with which to drill a complete round.

RESULT OF A CHANGE OF SYSTEM.

The same conditions hold in Western states. A case similar to the above occurred in one of the large Mother Lode mines of California. The company operating the mine had from 100 to 200 men on its payroll. The mine finally shut down, having a deficit of $90,000 for the year. The company then leased the different levels to some miners who had previously worked for it. Thirty-four lessees produced nearly the tonnage that the average 150 company men had. The lessees in most of the cases made good 'stakes' from the leases. The company had poor steel conditions; not only insufficient steel, but the heat treatment was very poor. The lessees had one of the best men on steel to be found. There are hundreds of cases of this kind in the country, where the cause of loss is due to neglect of the fourth factor alone.

LOSS OF STEEL IN MINES

Before considering the remedy for this state of affairs, the question of the loss of steel in the mine should be considered. This decides the quality of steel in some cases. Managers will often state that they use cheap instead of high-grade steel because the financial loss due to the losing of steel underground is greater than the saving made by the use of high-grade steel. In one mine in California, 600 new drills were sent underground and within six months only 150 were left. By searching the mine thoroughly, about the same number were found hidden or thrown in obscure places. So in six months half of this new steel was lost.

A GOOD WAY TO DISTRIBUTE STEEL

To secure the highest efficiency in drilling, each machine man should have, on arriving at his working place, a complete set of drills, properly sharpened and heat treated. This could be accomplished in many mines by having the mine carpenter build a rack for each working place, or else iron racks could be made in quantities. Each should have two compartments with different locks. The rack should be kept as close to the working face as practicable. When the machine man comes on shift in the morning, he finds his complete set of drills near his work. On finishing his round, he replaces all the drills, dull ones 'bit' upward. The night men also find a complete set of sharp drills in their compartments of the racks. During the night shift, the 'nippers' would take out all the dull steel from the day shift's compartments and return sharp drills later on. The 'day nippers' would handle the night shift's drills. The steel for stoping machines should be near the manways into the stopes. Keys to the racks should be turned in at the end of each shift, and the shift bosses should see that each machine man, on coming on shift, is given a key to his rack. 'Nippers' should have master keys to the compartments holding steel of the *opposite* shift, while shift bosses should have the master keys to the compartments holding steel for *their* shift.

By the use of this system the best quality of steel could be purchased, as the loss from missing steel would be cut down to the minimum.

HEAT TREATMENT OF DRILL STEEL

The heat treatment of drill steel has a more important bearing on drilling efficiency than any other one factor. The effects on drill steel due to improper heat treatment may be classed under the following heads: (1) dulling of the cutting edge of the bit; (2) breaking of the bit, due to 'checking'; (3) loss of gage.

The first entails loss of power due to the crushing of the rock, instead of its being chipped. This means less footage or else necessity for more drills. Breaking of the bit due to imperfect cooling, causing the drill to 'check,' may mean the loss of a hole, decreasing the effective footage drilled. The last effect, however, is the one that causes the greatest losses in efficiency. Drills that lose their gage rapidly may cause loss of holes, due to the fact that the next longer drill will not follow. In attempting to make a bit follow one that has lost its gage, much time and energy is wasted. The psychical effect on the miner is of great importance also. Often the machine will have to take the punishment, a sledge being used to loosen the bit and sometimes the blows fall on the piston rod or other vulnerable parts of the machine.

The loss of gage is due to the corners of the bits being too hard or soft. In the first place, the corners chip off and in the latter they rapidly wear, especially if drilling in abrasive rock. The heat treatment, in most mines today, depends on the eye of the blacksmith or helper. As it is impractical to draw temper on large drill steel, the heat treatment is generally conducted as follows: After sharpening, the steel is allowed to cool below the 'cherry red' temperature and then is given a 'short' heat. This means that only the extreme end of the drill, for a fraction of an inch, is heated to 'cherry red.' It is then 'quenched' thoroughly. The cutting edge is therefore of hard, untempered steel (fine grained, porcelanic texture), cushioned by a large mass of soft steel behind it. If the 'heat' at quenching is too short, the hardened portion will also be too short, and in drilling hard rock, will be driven back into the cushion, deforming the shape of the drill. If the heat is too 'long,' the cushioning effect is not sufficient and the corners chip off. Should the length of the heat be correct, the drill will stand up satisfactorily against the hardest rock, provided high-grade steel is used. As the color of the heated bit varies under different conditions of sunlight or artificial light, it is difficult to find a man who is able to heat and quench at the proper point.

If more attention were paid to the questions of sufficient steel at the working face and proper heat treatment of the steel, higher efficiency and lower costs would result. Several of the largest mines are going into the question of heat treatment, but the great majority of the mines are leaving this important factor to the blacksmith.

ABRASIVES FOR SANDBLASTING

BY H. D. GATES*

Tests of castings show shot and grit to have approximately 60 times the life of sand. In an instance of the use of grit with a hose machine, a steel foundry reports three tons loaded into the system and a loss of but 10 per cent. noted at the end of a month, while with sand the daily loss by disintegration was 25 per cent. This latter is undoubtedly excessive, and may have been due to a poor grade of sand. In this instance no advantage in rapidity of cleaning was apparent with the grit over the sand.

In another foundry the cleaning time of sand was reduced 20 per cent. by using shot. This seems logical, as the metal abrasives have two and a half times the specific gravity of sand. Records kept for six months showed, with same apparatus and conditions, that one pound of shot was equal to about 20 pounds of fine silica sand. Pieces cleaned were steel weighing approximately 200 pounds. The shot was of a size that an average of 33.7 per cent. was retained on number 20 mesh screen, and 66.3 per cent. on a number 40 screen. Experience in this plant was that shot made a great saving over sand, as it did better work, eliminated necessity of large storage bins, the cost of handling and driving sand, and by its lesser disintegration created less dust, making better conditions for the operator.

On the contrary in some experiments with metal abrasives on material to be electrogalvanized it was found that with equal power consumption perfect results were obtained with sand, while the metallic dust of the metal abrasive adhered to pieces, and imperfect galvanizing resulted.

On account of high cost of metal abrasives, their use with hose type machines must be confined to systems that have tight rooms and provide automatic handling. Thorough separation of dust and abrasive must be assured in the use of either for best efficiency, and the methods to obtain this adapted to the abrasive.

Use of a local sand is often possible, but aside from its abrasive value and hardness its size or grade will be of utmost importance, being governed entirely by size of nozzle.

While the larger the nozzle used, the greater the volume of work accomplished and the coarser the sand can be; air flow increases so with the larger nozzle that the available air supply for sandblast use must determine the nozzle opening, and it is obvious that the sand must be carefully screened to size in order to freely pass the nozzle.

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*De La Vergne Machine Co.

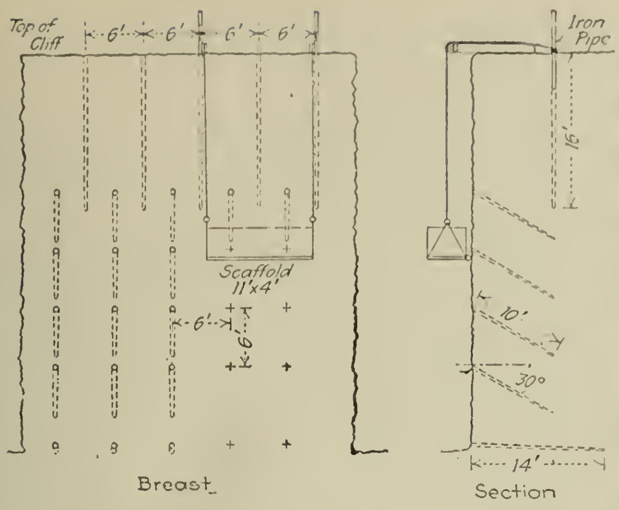

FIG. I.

QUARRYING WITH AIR HAND DRILLS ON SCAFFOLDS, SLINGS AND LADDERS*

BY CHARLES C. PHELPS

Since the advent of the self-rotating hand hammer drill certain new methods of ledge and cliff excavation have been successfully developed which would have been impracticable with any previous type of drill. Formerly the familiar bench method was usual, the rock being removed in steps whose depth and width depended upon the size of mounted drills employed. Frequently deep holes were cut from the top of the cliff by churn drills and drill wagons.

In the new method, a support for the workmen is lowered over the edge of the cliff. There being no drill mounting to adjust, the time consumed in setting up and in changing steels is practically eliminated. This always consumes a large part of the time of operation with all types of mounted drills and explains the great economy of hand drilling. Yet the methods here described would have been impractical with earlier hand drills, due to the difficulty of rotating them by hand in inconvenient positions.

Fig. 1 and 2 show the scheme employed at the Campbell & Deane Co. quarry, Straw Plains, Tenn. The rocks is a hard blue limestone. Formerly, mounted piston drills (3½x 6-in. cylinders) were employed to remove the rock in benches. These were capable of drilling holes up to about 2¾ in. starting diameter, and a maximum depth of about 16 ft.

The present procedure is as follows: A row of vertical holes, 16 ft. deep and spaced 6 ft. apart, is put in parallel with the face of the cliff by the tripod drills. Two lengths of gas pipe are inserted in the proper holes and ropes are fastened to them so that a scaffold can be lowered over the face of the cliff. The scaffold, shown in Fig. 2, is 11 ft. long and about 4 ft. wide. It is fitted with winding drums so that the drillers can raise or lower it after it has been slung over the cliff. The hand-drill holes are spaced 6 ft. apart, vertically and horizontally, and are 10 ft. deep. At this depth, the steels cut to about 1⅜-in. bottom diameter. The holes are inclined downward at an angle of about 30 degrees from the horizontal. Under present conditions, one man with a hand drill sinks about 80 to 100 ft. of hole per 10-hr. shift.

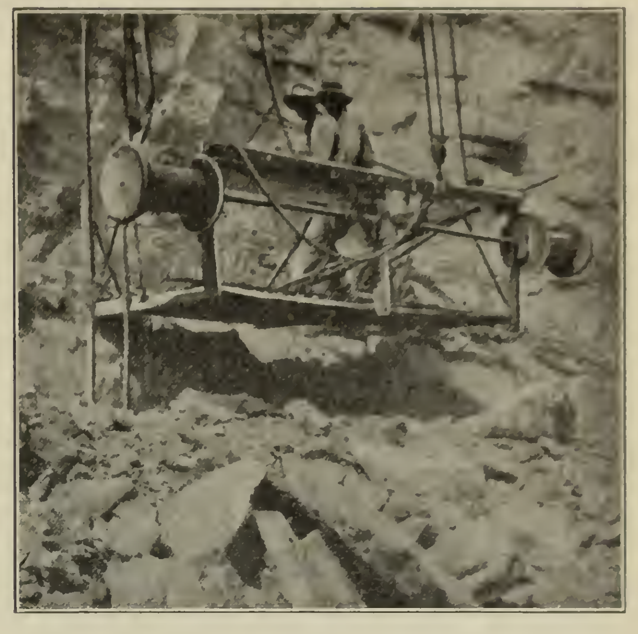

FIG. 2.

After the 10-ft. holes have been drilled from the top of the cliff to near the bottom, tripod drills are again put into use for drilling a line of horizontal holes on the very bottom of the cliff, these holes being 14 ft. in depth and looking down slightly from the horizontal. The holes in the side of the cliff are loaded each with 12 sticks of 60% dynamite and those at the bottom with 18 sticks. All of the holes are shot simultaneously (by battery). The cost of powder per cubic yard of broken stone is about 3½c. with this system whereas last year, when only tripod drills were used, the cost was 5½c.

Several big blasts have already been made. In the first shot that was set off an insufficient

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*Abstract from *Eng. News*.

quantity of powder was used, which resulted in large sizes of some of the stone. Later, 350 lb. was used (as noted above), and the cost quoted is based on this. It is believed that this amount can be reduced slightly and it is also contemplated using a slightly longer scaffold so that two or three drills can be used at once, which would result in a further lowering of operating cost. With the 350-lb. charge of powder, the rock is so well broken up that practically all of it can be handled by the steam shovel and crushers, requiring practically no block-holing.

The ease with which the automatically rotated hand hammer drill is handled in inaccessible quarters was further illustrated in work at the Bullwhacker Copper Company mines, at Butte, Mont. The difficult nature of the "glory hole" mining here may be realized when it is considered that it is 75 feet from the operator's position to the bottom of the cut, where the broken ore is mucked into cars and hoisted on an incline to the surface. The material is relatively low grade, averaging 4% copper, the vein running about 125 ft. wide at this point.

Frequently the operator works from a boatswain's chair slung over the side of the cliff. In a particularly difficult spot a suspended ladder had to be resorted to, the operator bracing himself against the ladder and having only sufficient room for one foot on the rock.

In spite of the exceptional difficulties at the Bullwhacker mine, the remarkable speed of 90 ft. of hole in two hours has been made, each hole bottoming at 6 ft. The rock, however, was not hard, it being an oxidized granite. Three-foot starting steels were used, followed by 6-ft. drills, the holes being for 1¼-in. powder sticks. In a single month, one drill broke enough ore to fill 64 cars of about 50,000 lb. each.

In the two instances cited, it twould be quite impossible to employ heavy piston drills. Ordinary plug drills would also be extremely difficult to operate because of the difficulty of rotating them by hand in such cramped quarters. With the self-rotating hand type, however, the operator has merely to apply the tool to the spot to be drilled and open the throttle. A simple steel holder attached to the front head of the hand drill has been found of material aid in withdrawing the steel from the hole. Moreover, it enables the drill runner to lower and raise the steel in the hole, churning up the cuttings and preventing sticking or binding. The latter troubles are still further provided against and the speed of cutting has been increased by a hole-cleaning device with which the operator can send at will a jet of air through the hollow steel to the bottom of the hole.

The writer desires to acknowledge the assistance of L. F. Thompson, of Knoxville, who furnished the data concerning the Campbell & Deane quarry, and of C. M. Hansen, of Butte, who supplied the information on the work at the Bullwhacker mine.

PNEUMATIC COAL TRANSPORTATION

In a paper read before the South Wales Institute of Engineers, Mr. Edward Koenings describes a pneumatic method of transporting small coal, such as peas, nuts, etc., which has met with some success. It is pointed out that the pneumatic principle has been applied in practice to the transport of seed, more especially corn, but only recently to coal. Small coal is not so uniform in size as a certain quality of grain, and it usually contains moisture which makes its suction into pipes difficult; a secondary trouble is the dust created. The difficulties have, however, been surmounted and the author proceeds to describe actual plants in use. One of these in Austria deals with 200 tons of coal in 24 hours, and consists of a double-cylinder air-pump by means of which a vacuum of about 10 inches is created in a cylindrical receiver, and two cylindrical dust catchers. To the lower part of the receiver three flexible suction pipes lead, each fitted with an isolating valve, so that either pipe may be used, two being for unloading wagons and one leading to a coal storage 200 yards away. Each suction pipe is fitted at the inlet with a special nozzle, and when in use the incoming current of air carries the coal and dust to the receiver, where the coal falls by its own weight into the lower conical part; it is ejected through an automatic airtight discharge valve on to an automatic weigher, and subsequently passed to a receiving bunker. The dust in suspension in the receiver is drawn into the filters, collected and discharged in the same way as the coal, the remaining air passing through the pump for discharge to the atmosphere. The only attendants required by the plant are the engineer in charge of the pump and the workman looking after the suction nozzle. The only important mechanism is the pump, and the operation is dustless so far as the workers are concerned. Another (German) plant is described for feeding 15 boilers. In this case the coal is taken from barges 160 yards away, lifted 110 feet and passed through the type of receiver mentioned, weighed and deposited in bunkers by means of a belt conveyor. In this instance no filter is used, as a dry lubricating air pump is installed, and dust collectors are fitted between the receiver and pump. The pump is rated at 2,400 cubic feet per minute; the capacity of the plant, 26 tons an hour from the barge, is increased to 45 tons if coal is taken from a bunker close to the receiver. The power required is 65 h.p., and the attendance from two to three men; it is estimated that the plant will pay for itself in two years. Another plant deals with eight tons an hour, over 100 yards and a height of 70 feet, and requires 18 h.p. The writer considers this form of transport most useful over a distance of 100 to 300 yards; the limiting size of coal he fixes at 2 inches, and of moisture at 6 per cent. He suggests that there may be scope for such apparatus for lifting small coal from the pit bottom to the surface.

SOME QUEER COMPRESSOR BUILDING EXPERIENCE

I think it will enliven my narrative to tell here the story of the Crown Point compressor. The Crown Point mine had long been under the control of the Bank of California crowd. It needed a new and large compressor, and I urged its management to order one of my new compound type, which they did.

We completed this compressor in four months and had it set up and tested in the shop, a fine foundation having been built for it at the Crown Point mine. Just about the time that we were ready to take it down for shipment the Bonanza crowd got control of the Crown Point mine. Mr. Taylor, president of the Risdon Iron Works, came to the office one morning in great trouble and called me into a private room to inform me that the enemy were in control at Crown Point and it was all up about the compressor.

"Now," said he, "you seem to be on better terms with Mr. Fair than any of us, and I want you to go up to his office and see what you can do about it." So to Mr. Fair's office I went with great trepidation, for he might be in a bad humor, in which case I had little chance of accomplishing anything. I found him in his office evidently elated over the Crown Point business. When I entered he said heartily, "Be seated, Mr. Dickie; now what can I do for you, my son?"

"Mr. Fair," I said, "I have come up to see you about the new compressor for Crown Point. It is all ready and has been tested in the shop, and I thought you might like to come down and see it run before we ship it."

"But," he replied, "I do not want that compressor."

That remark made me feel rather downhearted, so I ventured cautiously to extol the virtues of my compressor, and said, "Mr. Fair, why don't you want that compressor; it will be more economical than any compressor now on the Comstock by at least 30 per cent."

Then he let me in on some of the economics of mine control by replying, "Now, my son, you've got it. We have got control of that mine, so that if we can't get metal out of her we can put wood into her; we are selling Crown Point 80 cords of wood per day and an economical compressor will cut down our sales."

"Mr. Fair," I said, "the foundations are all complete and the holding-down bolts in place, ready to receive the compressor, and you cannot afford to leave it incomplete, so you had better let me ship it, especially as a great many mining men are anxious to see how it will turn out."

"Now, my son," he said, "you had better not say anything more about it; we are not going to take that Compressor." "Then," said I, "what are you going to do about our contract?" "Oh, you have a contract have you? Robert, where is that contract with the Risdon for a compressor? Ah, my son, here it is, $46,000. It seems to be all right. Robert, make out a check to the Risdon Iron Works for $46,000 on Crown Point account."

BURYING A NEW IDEA

"That's all right," I said, "but what are we to do with your compressor?" "How big is this thing, my son?" I told him about 20 ft. long, 17 ft. high and 8 ft. wide. "Well, my son, it's pretty big—too big to bury it standing up, as you get into water pretty quick down at your place, but dig a nice hole and lay it on its flat. You can go down 9 ft., and cover it up carefully; no headstone, I want your compressor to have a nameless grave and we'll say no more about it."

So ended the chance for a real two-stage compressor, and it was 15 years before anyone else built a compound compressor. Passing some time ago the site of the old Risdon Iron Works, I came across one or two parts of the old Crown Point compressor; probably no one but myself could identify them. In those days we had some rather strange experiences in our endeavors to advance science and engineering.—*Geo. W. Dickie in American Machinist.*

SOMETHING FOR NOTHING IN COMPRESSED AIR

The following comes to us from the *Kansas City Post.* The device spoken of will evidently be a wonder when the "few alterations" are completed.

An engine that runs itself on its own power, developing energy to operate machinery, has been invented in this city. The inventor has been working for five years on his self-operating engine, and now has it near perfection. A few alterations are to be made. These will increase its efficiency. The engine is run by compressed air, making its own pressure as it runs. The exhaust from the cylinders returns through a series of eight-port automatic valves, to a large steel pressure tank. This tank is a double affair, there being a smaller tank within the larger one. An air space of 6-in. intervenes between the two tanks. Into the air space the exhaust from the cylinders is forced, the action being such that the nitrogen gases are separated from the oxygen and, forming a lighter gas, rises to the top of the tank, at the same time creating a pressure which forces the fresh air down through the inner tank and back into the engine, which is operated by this pressure.

OXYGEN SUPPLY WITHOUT PRESSURE

Instead of using strong mechanical containers for oxygen as a compressed gas chemical constraint can be substituted. Thus oxone is a substance in which oxygen is held in chemical bonds, but is releasable by the application of water. Just as water reacts with calcium carbide and forms acetylene gas and lime, so water reacts with oxoe and forms oxygen and sodium hydrate. A pound of this reagent holds 2.2 cub. ft. of gas or 60 litres of oxygen at normal pressure and temperature. Thus a pound of oxone should furnish a man enough oxygen for 30 minutes of use. The oxygen evolved is said to be 99 to 100 per cent. pure, the only impurity consisting of a slight vapour caused by the energy of reaction. This is readily absorbed by passing the gas through water. The gas is then of 100 per cent. purity. Oxone is a commercial preparation of fused sodium peroxide of specific gravity 2.43. It is hard, but not brittle, and is capable of being cast into any convenient shape, and it is said it can be stored without danger and even without deterioration if protected from moisture.

A PLANT THAT COUGHS

All have read of carnivorous plants, of laughing plants and of plants that weep, but who has heard of a plant that coughs? There is a plant in various tropical regions which actually possesses the power to cough in the most approved manner. It appears that the coughing plant is something of a crank, that it easily works itself into a rage, and that it has a curious horror of all dust. As soon as a few grains of dust are deposited on its leaves the air chambers that cover their faces and are the respiratory organs of the plant become filled with gas, swell, and end by driving out the gas with a slight explosion and a sound that resembles so much the cough of a child suffering from a cold as to carry a most uncanny sensation.

A STONE QUARANTINE

Probably for the first time in the history of the world a quarantine has been declared against stone, and it is now being enforced against the quarry products of certain parts of New England. Owing to the fact that egg clusters of gypsy moth were being distributed on quarry blocks from the infected districts to other sections of the United States, the Secretary of Agriculture placed such products under regulation as to interstate movement by a quarantine effective October 23, 1914. In accordance with this action the railroad companies have notified shippers that before any car, box or other container can be moved from the infected districts, it must be plainly marked and bear a certificate of inspection.

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THE GREAT DISAPPOINTMENT

With our present issue another volume of Compressed Air Magazine begins, and it would be quite natural for us to be thinking and speaking of its outlook for the future. With world affairs in normal condition it should be expected that we would be considering the special topics to which our publication is ostensibly devoted; but it is impossible to forget or ignore the conditions under which we are at present existing. All the world is upset, and wiseacre historians hundreds of years hence will be showing that the upsetting was the operation precedent to a firmer settling of the foundations of life and conditions on the globe, and that the cost of the repairs was commensurate with the value of the work accomplished.

Nevertheless, the universal tragedy of the present, in view of what we were confidently expecting of permanent peace and continued average prosperity and progress, must, for the time at least, stand for one of the world's great disappointments. It came upon us with startling suddenness, and to the masses of mankind as a complete surprise, and if it could have been predicted in advance it would have been almost universally declared impossible. Under existing conditions perhaps the most futile of undertakings is to attempt to place the blame for it all, except in so far as that may lead to the means of restoration and readjustment. All that we can do is to take things as they come and to hope and resolve that so far as may be possible we shall keep out of more immediate contact with the great trouble.

When we come to look into the actualities of the great war we find that pneumatics in one way or another is involved in all the great operations. This war has developed departures from the traditional ways of fighting, and has sprung surprises in the development of efficiencies along unusual lines that are the wonder alike of the expert and of the uninformed. Sky craft and the submarines were never employed until the present war; now they are the most terrible and, directly or indirectly, the most effective and terrible of all the agencies employed, and air is as essential in the operation of the one as of the other.

Compressed air has been working quite innocently but quite constantly toward the development of the most effective of the physical agencies of the destruction now so active. The rock drill in quarry and in mine, in driving tunnels and in all rock excavation, has continually stimulated the development of the high explosives, and now we reap the benefit in the harvest of death.

TESTS OF ROCK DRILLS AT NORTH STAR MINES, CALIFORNIA

BY W. L. SAUNDERS

[The following is a discussion of a paper with the above title by Robert H. Bedford and William Hague, presented at the Salt Lake meeting, August, 1914, of the American Institute of Mining Engineers and printed in the Bulletin of the Institute No. 92].

Messrs. Bedford and Hague have given us a very interesting and practical paper. No better excuse for such a paper could be desired than the statement made that the expense of drilling in this mine is one-third of the cost of delivering the ore at the mill. This statement should be written in red letters, because it applies to a great many mines besides the one referred to and because it is generally true that in a mining plant, as also in papers read before the Institute, more attention by far is given to the metallurgical side of mining than to the excavation of the ore, and no study of the excavation work is properly made that does not involve a careful inquiry into the merits of the rock drill used.

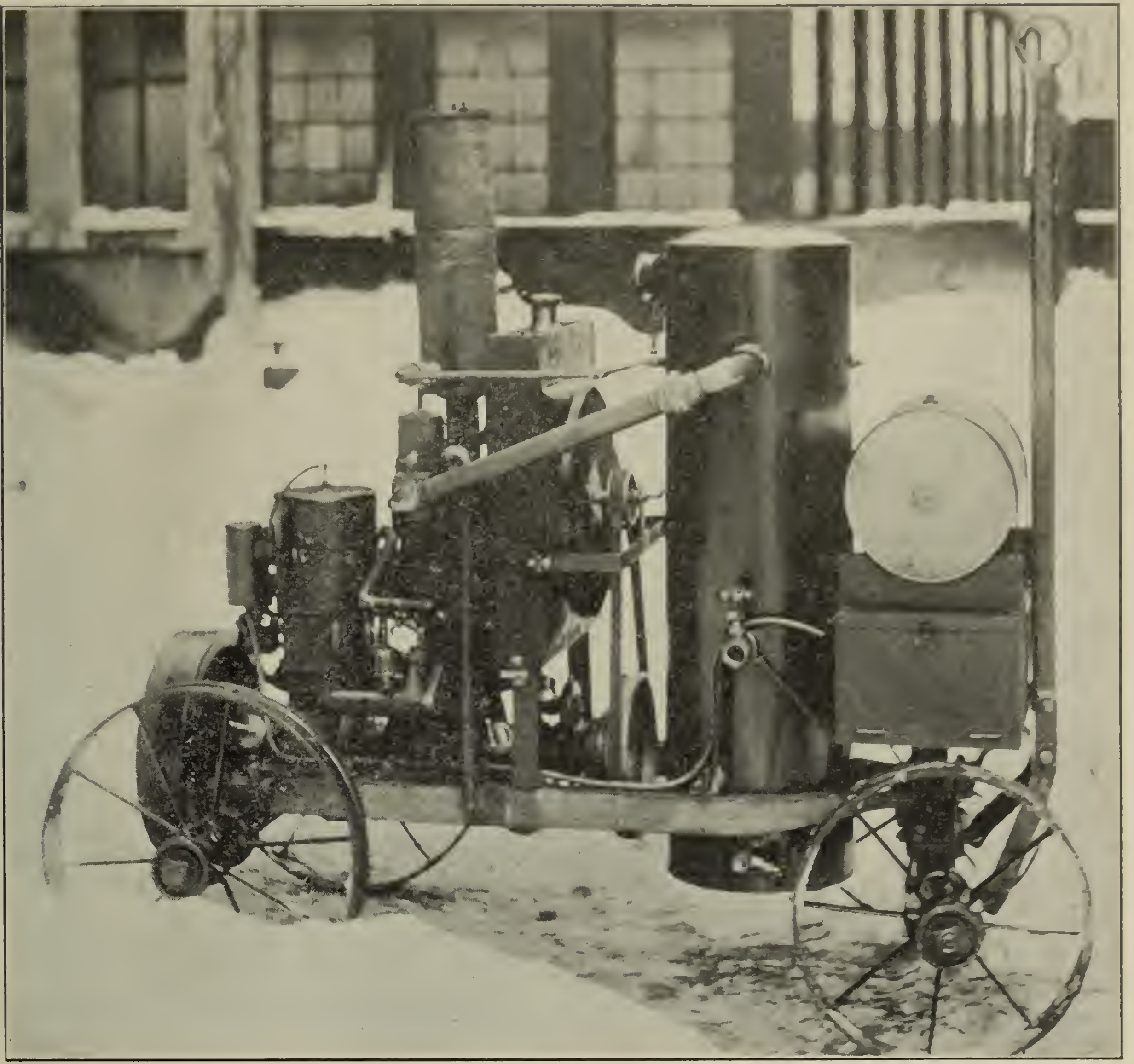
Next in importance to the selection of a good rock drill, in a case where the actual drilling cost is one-third the cost of delivering the ore, is that the drill should be maintained in order and kept up to its highest efficiency. The best rock drill may run down in efficiency through accidents, wear, or other conditions which are sometimes beyond supervision or control. The machine is usually in the hands of men who know how to get work out of it, not men who know how it works. The best drill runners are not machinists, but miners. They could not tell you how the valve operates or the principle of the rotation, but they know how to get the work done. A testing machine, particularly the type described in this paper, may be of the greatest value in maintaining a uniform state of efficiency.

It must not be supposed, however, that this testing machine in itself will distinguish the value of one type of drill from another. This has been referred to in the paper, where it is shown from the record that drills developing the greatest horse power of energy were not the most efficient in drilling capacity. This is referred to on p. 1814 and it is corroborated by the tables on p. 1813, where the foot-pound blow of approximately 40 to 45 lb. is shown to be the most efficient for this particular class of work.

At the works of the Ingersoll-Rand Co. testing machines of practically the same principle as that described have been in use for several years. Drills are tested on these machines and afterward operated in an experimental underground mine, where it has been shown that the maximum foot-pound energy does not always mean maximum drilling capacity. The efficiency of any type of rock drill depends mainly upon the proper adjustment of the air pressure to the nature of the rock. In certain rocks a slow-moving, heavy foot-pound blow will show the best results in drilling, while in other rocks the fastest drilling is done through a rapid blow of light foot-pound energy.

The testing machine, however, is a guide in showing comparative results under similar conditions and it is a valuable means by which from time to time a drill may be tested to determine whether or not it has deteriorated. A rock drill that is not up to its maximum efficiency should be examined and the cause discovered and remedied.

It is to be regretted that Messrs. Bedford and Hague did not give us a little more information concerning the tests given in the tables. These tables at a glance indicate that a comparsion has been made between the cost of operating a water Leyner No. 8 drill and a Waugh 12-A. I feel quite sure, however, that there is no comparative test intended, because, in the first place, one machine is a rock drill of the mounted type while the other is an unmounted stoper. In these tests the Leyner drill was used for heading work, which means that a larger proportion of the holes are flat and down-holes. Such work, as every one knows, is more difficult and is harder on the steel than work, commonly known as stoping, with air drills, which is usually up-hole work, the drills clearing themselves of cuttings during operation. This point has a bearing upon the statement showing the amount of steel consumed and the cost per shift for sharpen-



PORTABLE GASOLINE ENGINE COMPRESSOR.

ing the steel. There can be no comparative value placed upon tests of steel cost except when used in the same class of work. Furthermore, the Leyner drill was used with round steel while the stoper used the cruciform pattern. The statement is also made that 2-in. bits were used with the stopers and 2¼-in. with the Leyners.

Another point worth mentioning is that the Leyner drill (No. 8) referred to in this paper is no longer made, it being an obsolete pattern, the present type being No. 18.

The point brought out in this paper that the force of the air feed on a stoper has a very material effect upon its drilling capacity is one not generally considered, but it is of the utmost importance in stoper service.

A SMALL PORTABLE AIR COMPRESSOR

The small gasoline-engine-driven portable air compressor illustrated above has been developed by the Ingersoll-Rand Company, particularly to meet the needs of the contractor doing work of a temporary character requiring compressed air in small quantities, such as the laying of gas and water mains, where air tools of various types are used, for cutting asphalt, tearing up roadways, rock cutting, calking lead joints, drilling and riveting on steel pipes, tamping earth, etc. Compressed air tools have demonstrated their merit on this class of work and in every case have proved a considerable saving, both in time and labor, over hand methods.

This compressor being portable and self

contained is admirably adapted to this work. It is operated by a simple single cylinder gasoline engine which is coupled directly to the compressor, both pistons working from alternate cranks on the same shaft. The engine is of the single acting, two cycle type, closely following the well known marine designs. The air compressor, which is one of the Companies standard types, known as "Imperial XII," has a capacity of 45 cu. ft. per minute at a pressure of 90 lb.; it is fitted with an air unloader and the engine with a centrifugal governor.

Cooling is provided for by a gear driven pump and an automobile type radiator with large tank capacity, serving both the compressor and engine. The radiator is assisted by a large fan.

The frame, axles and wheels are of steel, the front axle is arranged with a swivel connection to the frame, permitting horizontal rotation for turning corners and sufficient vertical movement to accommodate the wheels to inequalities of the road without strain on the frame.

An air receiver, tested to 300 lb. water pressure and fitted with safety valve, pressure gage, necessary piping, outlets, etc., is hung at one end of the frame, and a gasoline tank of 15 gallons capacity is supported on a large tool box as shown in the illustration.

The outfit complete weighs 1600 lb.; it is designed for hand transporation but can be fitted for horse traction if desired.

This outfit is rated in terms of pneumatic tools of its make as follows:

Three medium size "Little David" chippers.
Two "Crown" pneumatic picks.
Two "Little David" riveting hammers.
One "Little David" wood boring drill or one metal drill.
Two "Crown" sand rammers.
Two small plug drills or one Jackhamer.
One medium size "Imperial" hoist.
Ten small stone tools or six of the large size.

TEST OF THE LARGEST AIR COMPRESSOR

BY G. M. CLARK.*

The official test of the largest turbo-compressor hitherto constructed marks an epoch in the history of the design of such machines, and is therefore worthy of a fuller description than would generally be accorded to a taking-over test between a contractor and a purchaser. The machine is used for delivering compressed air to the mines belonging to the Rand Mines, Limited. Air is delivered through a network of pipes 30 miles in length and varying in diameter from 27½ inches downwards to 20 points of supply at a pressure of 100 to 110 pounds per square inch gauge pressure. The total capacity of these pipes is nearly 90 tons (of 2,000 pounds) of air, and the power installed to drive the compressors is nearly 60,000 K.W. The machine runs at 3,000 revolutions per minute, and is rated at 7,000 K. W. on the turbine, and is one of three similar machines installed under the same contract. The machine has an overall length of 56 feet. The low-pressure stage is next to the turbine, and is double ended. The air at atmospheric pressure is taken in at each end, and is discharged by a duct at the centre. This automatically balances the end thrust on this stage. From the first stage the air passes through the first intercooler, then through the second or intermediate stage, and then through the second intercooler, and, finally, through the high-pressure stage. All stages are water-jacketed, and water also circulates through the diaphragms. Compressed air contains no more energy than the same volume of uncompressed air at the same temperature, so that all the work done in compression has to appear in the cooling water. The compression that takes place in the first stage is from atmospheric pressure to about 0.8 atmospheres above, whilst the second stage raises the pressure to nearly 3.0 atmospheres, and the final stage to 9 atmospheres gauge pressure. The temperature of the air entering the compressor is nearly 20°C., with a rise to 80°C. at the end of the first stage. It is again cooled to 30°C. in the intercooler with circulating water at 20°C., and leaves this stage at about 100°C., after which it is again cooled to 35°C. in the second intercooler, and finally rises to 90°C. in the high-pressure stage. The isothermal compression is completed by the final cooling in the pipe line distribution system to the original atmospheric temperature of 20°C. These temperatures and pressures vary with the load on the machine, but the above statement is nearly accurate for the full load of the machine.

The tests, which were carried out in August, 1914, were officially for the purpose of deciding whether the guarantees were fulfilled, and subordinately for the purpose of giving information to the operating staff as to the behaviour of the machine. The Power Company does not sell air in terms of air-kilowatt hours as defined above, but in terms of air units, which are defined as 64.1 per cent. of an air kilowatt hour. This fraction was introduced so that the selling price of an air unit and of an electric unit might be the same. It would have been as simple to have sold air by the air-kilowatt hour and made the price of each 100/64.1 of the price of an electric unit. This air unit is introduced into a part of the subsequent calculations and represents approximately what the machine would have done had an electric generator been attached to the turbine instead of a compressor. The figures derived from air units will thus be more familiar to electrical engineers than those derived from the air kilowatt. Though the method of testing and calculation had already been agreed and accepted, these tests are of such interest, and the results are of so great importance, that other methods of calculation have been used, and it is gratifying to know that the guarantees are fulfilled independently of the method of calculation.

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*South African Institute of Engineers.

The conclusions to be derived from this report on the tests is that, whilst a very great advance has been made in the size of turbo-compressors, this advance has been accompanied by another great advance in the science of design, so that the efficiency is now at least 10 per cent. above that of machines previously constructed by the same designers. From the figures given it is probable that three-quarters of the energy of the steam is convertible into mechanical work on the shaft of the turbine, and of the work on the shaft two-thirds can be utilized in the isothermal compression of air with compression ratio of nearly 12. Thus on the whole there has been an increase from a conversion of little more than 40 per cent. of the steam energy to practically 50 per cent. The report incidentally shows that the orifice method of measuring air and water is capable of being used with an accuracy equivalent to the commercial accuracy of electrical measurements. There is no doubt that measurements taken in this way are so accurate that to allow a tolerance of 2½ per cent. for accuracy of measurements is altogether too great. The report shows the facility with which steam measurements may be handled when the notion of the steam kilowatt is introduced, and the use of the Mollier diagram when converted to read steam energy directly in kilowatt hours per pound of steam gives immensely increased power of thought in all questions of turbine economy as compared with the use of ordinary steam tables.

A SAFETY FIRST TUNNEL

Out in the Cascades the Chicago, Milwaukee and St. Paul Railroad has just completed, after two years' work, a 12,000-foot bore through the granite and slate of the mountains without the loss of a single life. The St. Gothard tunnel in Switzerland, which is similar to the St. Paul's, took eight years to build and cost 800 lives. The St. Paul people have called their new tunnel the "lucky tunnel." During its construction, which took three years less time than had been at first calculated, giant air compressors kept the bore supplied with fresh air, while pulmotors, oxygen helmets, and every other safety device obtainable were employed to protect the men. The tunnel has been misnamed. It was not luck that made possible the completion of such a work without the sacrifice of a human life. It was a strict adherence to the principles of "safety first," and the result excellently serves to illustrate what can be accomplished when a real serious effort is made to throw every safeguard possible around men engaged in hazardous undertakings. So rather let the St. Paul name the bore through the Cascades the "safety first tunnel."—*Exchange, Unidentified.*

TWO KINDS OF CUT SUGAR

In the modern manufacture of "cut loaf" sugar, the "loaf" being a reminiscence of the older days when sugars were first made in loaves and then broken into pieces, the sugar is made in the ordinary way by the vacuum pan process, with large crystals and this large crystalled sugar is then moistened with a liquor or syrup made of pure white sugar and this is sprinkled in among the crystals to secure a certain degree of stickiness, or of adhesion of the crystals to each other, and the mass of sugar is then made into thin plates of about three-quarters of an inch thickness and then dried by artificial heat. In this way the brilliancy of the crystals is maintained and the sugar then is cut up into the little blocks with which we are familiar, certain indentations in the moulds directing the lines of cleavage, and we have the first-class cut loaf sugar.

In order to turn out a cheaper production there was invented a machine for making compressed cubes out of sugars from the centrifugals, generally of rather a small grain, and retaining some of the moisture which, with the compression in the cube sugar-making machines, made it possible to turn out the little compressed cubes with a smooth surface with which we are all familiar

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NOTES

The New York Public Library has recently published a 34 page pamphlet containing a list of works relating to oxy-acetylene welding which may be found in the library. The arrangement is chronological by date of publication from 1893 to October, 1914, and specifies 487 books, pamphlets, magazine articles, etc., indexed both by subjects and authors.

Over one-fourth of a factory's yearly coal bill is directly controlled by the firemen. In New England a single fireman will burn $40 to $50 worth of coal a day in a 500 horse-power plant. That is $12,000 to $15,000 worth of coal a year. This man receives from $1.75 to $2.50 per day for his work. Depending upon the skill with which he handles his shovel, he will waste or save $3,000 to $4,000 a year of his firm's good money.

The new third lock of the St. Mary's Falls canal system, said to be the longest lock in the world, was formally opened to navigation, Oct. 21. The lock is 1,250 ft. long, 80 ft. wide and 23 ft. deep. Its construction was begun in 1908, and the cost is given as $6,250,000.

A well-deserved and too seldom accorded honor is to be given to engineers by the Baltimore and Ohio Railroad. The four tunnels on the Magnolia Cut-off between Orleans and Little Cacaton, West Virginia, are to be named after four of the road's chief engineers: James L. Randolph, J. M. Graham, D. D. Carothers and Francis Lee Stewart.

The following is the record of heading progress on the Rogers Pass Tunnel of the Canadian Pacific Ry. for November:

East end, center heading, 588 ft. Schist with some quartzite.

East end, pioneer heading, 529 ft. Quartzite with some schist.

West end, pioneer heading, 817 ft. Slate with small quartzite bands.

West end, center heading, 654 ft. Slate with small quartzite bands.

The west end pioneer heading footage is believed to be the American record of rock-tunnel progress. This heading was driven down grade through rock that could not be broken over 6 ft. per round. The best day's progress was 37 ft. Joseph Murphy is Assistant Superintendent at the east end, and Joesph Fowler is Assistant Superintendent at the west end; A. C. Dennis, Superintendent; Foley Bros., Welch & Stewart, contractors.—*Eng. News.*

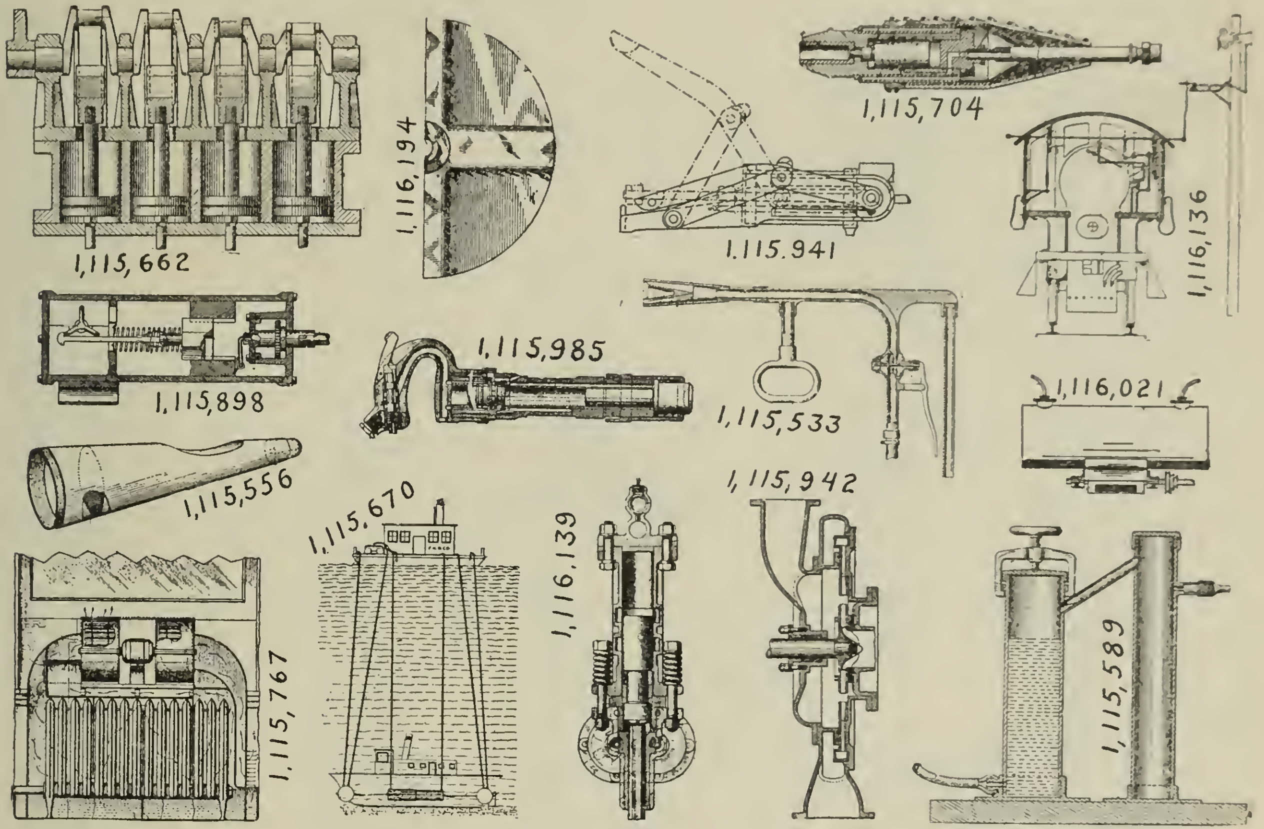
Ebensburg No. 1 mine of the Ebensburg Coal Co., at Colver, Penn., for the month of October, produced 102,700 net tons. This is remarkable, when it is considered that this is from a single opening, and the seam of coal only 3½ ft. high.

What is said to be the largest stack in the construction of any office building is that of the Equitable, New York City. It is 11 ft. in diameter and 596 ft. high. The two stacks of both the Campania and the Lucania, of the Cunard Line, were each 21 ft. in diameter.

Cost of working a 900-hp. Diesel engine at the Anheuser-Busch brewery, St. Louis, totals 0.6506c. per kilowatt-hour as follows: fuel oil, 0.2850c.; lubricating oil, 0.0263c.; water, 0.0388c.; supplies, 0.0043c.; labor, 0.2750c.; and maintenance and repairs, 0.0212 cents.

Commercial rubber which is kept in perfectly dry air is not capable of furnishing nutriment to any form of microbe, but in the presence of sufficient moisture it may be attacked by certain bacteria or molds which feed on albuminoids, resins, and sugars. Some microbes form red, yellow, brown, or black spots on rubber without sensibly altering its properties. But there are two species of Actinomyces which are able to assimilate the hydrocarbon of rubber, and which may therefore so modify its properties as to destroy its value.—*Scientific American.*

The value of carbonic acid gas as a plant nutrient has been the subject of considerable recent literature, including an interesting paper by H. Fischer, describing experiments in Germany. The author found that the development of both foliage and flowers was stimulated by an excess of carbonic acid in the air, while the yield of tomatoes was doubled and that of cucumbers increased 12.5 per cent by carbonic acid treatment. It has generally been held that 0.03 per cent. of carbon dioxide in the air is sufficient for plant growth, but Mr. Fischer thinks that more than this can be utilized, provided there is ample light, and that experiments in this direction might give valuable results.



Pneumatic Patents November 3

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 3.

1,115,533. BOILER-TUBE BLOWER. Roy Hartwell, Marion, Ill.

1,115,556. SOAP-BUBBLE-BLOWING DEVICE. George M. Little, Pittsburgh, Pa.

1,115,589. APPARATUS FOR INJECTING LIQUIDS INTO PNEUMATIC TIRES. Jacob J. Seaman, Winfield, Kans.

1,115,644-5. AIR-BRAKE MECHANISM. John B. Wright and Frans O. Lawson, Greensboro, N. C.

1,115,662. FLUID-PRESSURE CONTROL DEVICE. Leland F. Goodspeed, Milwaukee, Wis.

1,115,670. DEVICE FOR RAISING SUNKEN VESSELS. Flore Hengye, Joilet, Ill.

1,115,704. PNEUMATIC - HAMMER MUFFLER. Edward Manes, Golden, Ill.

1,115,767. AIR-CONDITIONING APPARATUS. Foree Bain, La Grange, Ill.

1,115,770. PNEUMATIC - DESPATCH - TUBE APPARATUS. Birney C. Batcheller, Philadelphia, Pa.

1,115,898. HAMMER-DRILL. Andrew J. Carter, Victor, Colo.

1,115,941. MANUAL OR FOOT-OPERATED AIR-PUMP. Henry Thomas Hutton, Donaghadee, Ireland.

1,115,942. CENTRIFUGAL PUMP AND AIR COMPRESSOR. Walter Kieser, Charlottenburg, Germany.

1,115,985. PNEUMATIC HAMMER. Lewis E. Summers, Detroit, Mich.

1,115,511. SAFETY DEVICE FOR PUMP-GOVERNORS. Philip L. Crittenden, Edgewood, Pa.

1,116,021. MILK-RELEASING MEANS IN VACUUM - OPERATED MILKING - MACHINES. Joseph Harvey Cornish, Barham, New South Wales, Australia.

1,116,136. AUTOMATIC AIR-BRAKE-OPERATING MECHANISM FOR RAILWAY-TRAINS. Walter R. Shaw, Bradford, Pa.

1,116,139. DRILLING-MACHINE. Mather W. Sherwood, Franklin, Pa.

1,116,194. VACUUM - PRODUCER. John Wynn, Jr., Canton, Ohio.

1,116,346. FLUID-PRESSURE ENGINE. Walter W. Macfarren, Pittsburgh, Pa.

1. A fluid pressure engine comprising in combination, means for regulating the pressure of the entering fluid, and means operated by pressure derived from fluid which has passed the first named means and arranged to vary the point of cut-off in such relation to the stroke as to permit expansion to be carried substantially to a uniform point before exhausting.

NOVEMBER 10.

1,116,368. VACUUM UNIT-VALVE. Miles E. Bell, Minneapolis, Minn.

1,116,374. VACUUM PISTON MECHANISM FOR LOCOMOTIVE DRIFTING-VALVES. Joseph Billingham and Charles F. Kahler, Schenectady, N. Y.

1,116,708. MILKING-MACHINE OPERATED BY COMPRESSED AIR OR THE LIKE. Frans J. Johansson, Stockholm, and Emil A. O. Gothe, Nynashamn, Sweden.

1,116,720. METAL - CASTING MACHINE. James J. McGuire, Newark, N. J.

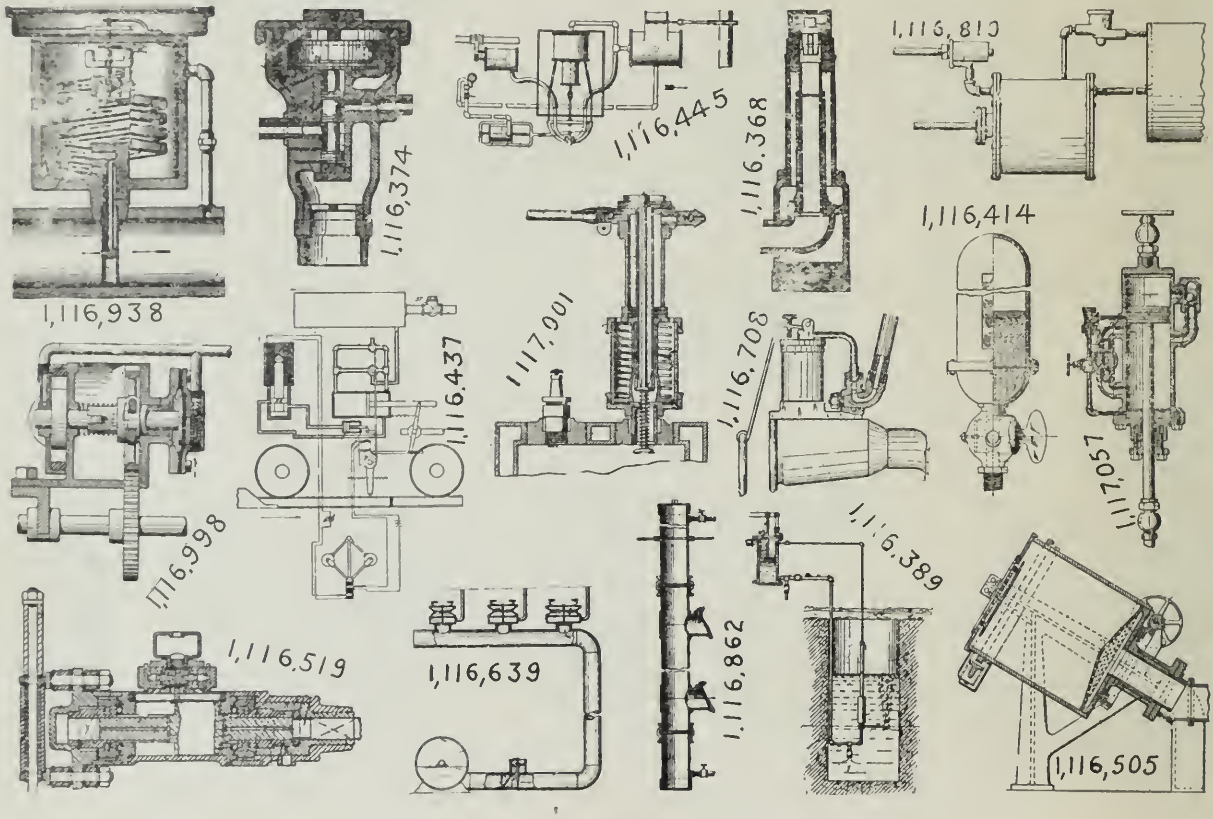
1,116,777. REDUCING SYSTEM. Milton F. Williams, St. Louis, Mo.

1,116,819. FLUID - OPERATED BRAKE. George E. Hottenstein and Robert Z. Farmer, Bisbee, Ariz.

1,116,850. SUCTION CLEANING DEVICE. George C. Schmitz, Racine, Wis.

1,116,862. PNEUMATIC CONVEYING DEVICE. William Wallace Wotherspoon, New York, N. Y.

1,116,938. FLUID-FLOW METER. Lucian A. Sheldon, Schenectady, N. Y.



Pneumatic Patents November 10.

1,116,389. PUMPING MECHANISM. Charles W. Collins, Tiffin, Ohio.

1,116,414. DEVICE FOR PREVENTING WATER-HAMMER. Robert D. Gould, Superior, Wis.

1,116,437. AUTOMATIC TRAIN-STOP. Elmer M. Jones, Atlanta, Ga.

1,116,445. AUTOMATIC SAFETY DEVICE. Edmund John Laclair, Providence, R. I.

1,116,505. SAND-BLAST APPARATUS. William W. Sly, deceased, Cleveland, Ohio, by Wilfred C. Sly, administrator, Cleveland, Ohio.

1,116,519. PERCUSSIVE HAMMER, DRILL, AND THE LIKE. William Henry Wakfer, South Norwood, England.

1,116,530. PNEUMATIC MUSICAL INSTRUMENT. Harry J. Anderson, Chicago, Ill.

1,116,564. AIR-BRAKE SYSTEM AND APPARATUS. Niels A. Christensen, Milwaukee, Wis.

1,116,639. VALVE FOR ORGAN-BLOWERS. Ira H. Spencer, West Hartford, Conn.

1,116,647. AIR-WASHER. Guy P. Thurber, Pittsburgh, Pa.

1,116,675. AIR-GUN. Edgar P. Cook, Granville, Ohio.

1,116,998. PUMP CONTROL. Melvin D. Compton, New York, N. Y.

1. A pneumatic device comprising the combination of an air compressor and an air line, a driving clutch for the compressor, a diaphragm for throwing the clutch, reversely acting check and relief valves and their ports for admitting and exhausting air to and from the diaphragm, and means for constantly exposing said valves to the air pressure in the line, whereby the compressor is automatically run when the air pressure is below a certain limit and is automatically stopped when the air pressure is above a certain limit.

1,117,001. AIR-PUMP. James K. Dalton, Waverly, Ohio.

1,117,057. AIR - SPRING AND SHOCK - ABSORBER. John Kohner, Lewiston, Minn.

1,117,119. SAND-TRAP. William H. White, Roanoke, Va.

NOVEMBER 17.

1,117,254. FLUID-PRESSURE BRAKE SYSTEM. William H. Sauvage, New York, N. Y.

1,117,267. VACUUM REGULATION. Homer Clyde Snook, Philadelphia, Pa.

1,117,289. TRIPLE VALVE. **Willis C. Webster**, Dubois, Pa.

1,117,307. FLUID-OPERATED TOOL. **Lewis C. Bayles**, Easton, Pa.

1,117,329. TIRE - PRESSURE INDICATOR AND ELECTRIC SIGNAL. **Charles C. Cleveland**, Boulder, Colo.

1,117,394. AIR COMPRESSING AND STORING SYSTEM. **Nels Joleen**, Chicago, Ill.

1,117,461. ROTARY COMPRESSOR. **Frank S. Strite**, Seattle, Wash.

1,117,548. SUCTION SUPPORTING DEVICE. **August Bouchery**, New York, N. Y.

1,117,554. DRILL-PULLER. **Howison Crouch**, Grass Valley, Cal.

An attachment for a hammer rock drill comprising a flexible member provided at one end with means for gripping the shank of a drill steel and at the other end with a bracket arm, the end of which is bent at an angle and adapted to be inserted into the drill socket of the rock drill so that upon supporting the rock drill in reversed position and reciprocating the hammer thereof, the impact of the latter will exert a pulling force upon the drill steel.

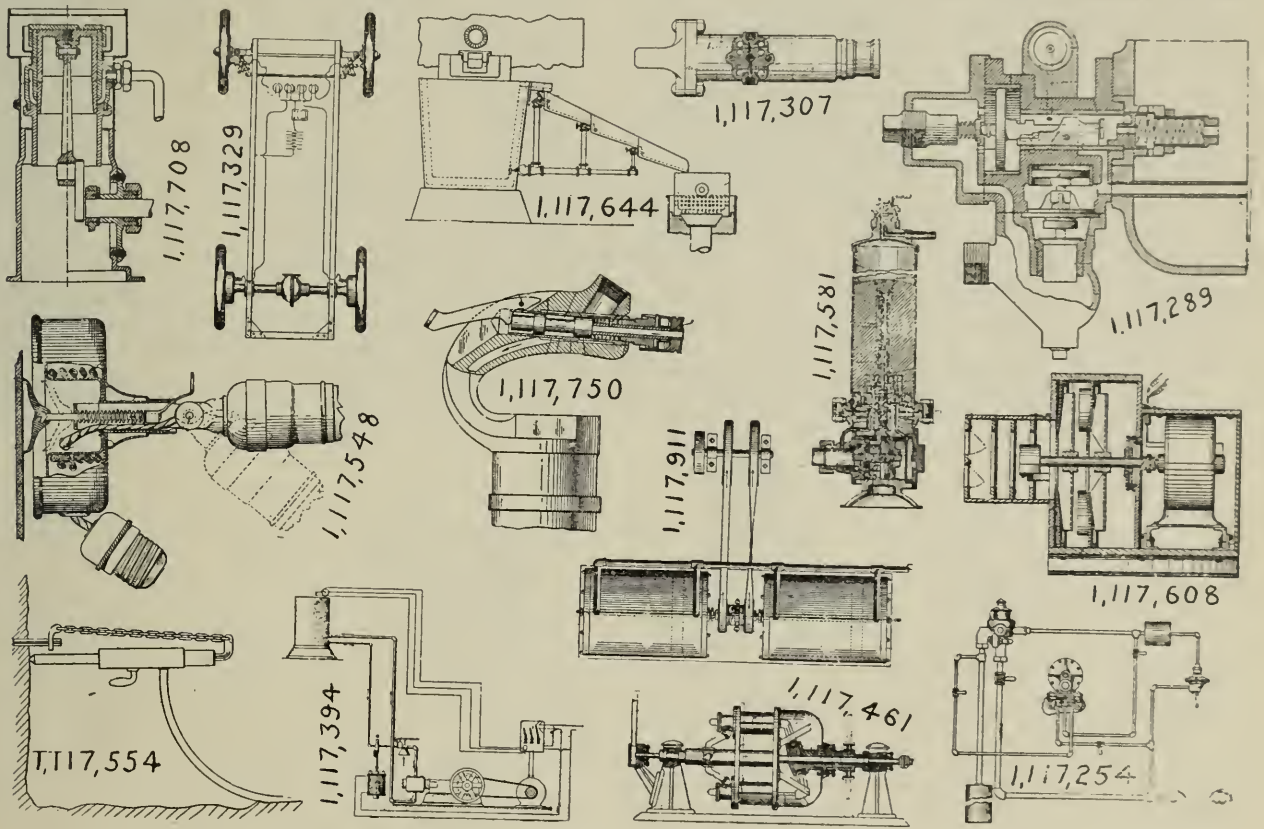
1,117,750. SAFETY LOCKING DEVICE. **Charles F. Albrecht**, Cleveland, Ohio.

1. A fluid pressure operated tool comprising, in combination, a barrel or cylinder, a handle for said barrel or cylinder provided with a passageway for pressure fluid, a valve in said handle adapted to control the flow of fluid through such passageway, a trigger carried by the handle for operating the valve, a device adapted to engage the valve and block it against movement by the trigger, means for retaining said device in blocking position, and a spring arranged to move said device out of valve-blocking position when the said device is released.

1,117,784-5. MEANS FOR HUMIDIFYING ARTIFICIALLY-HEATED AIR. **Addison A. Cardwell**, Rye, N. Y.

1,117,786. REFRIGERATING APPARATUS. **Carl A. V. Carlsson**, Washington, D. C.

1. The combination with an air circulating refrigerating system, employing high and low air pressures, and a source of supply therefor, of means automatically operated by the air pressure difference between the "high" and "low" parts of said system adapted to control the air pressure supply and circulation of said system.



Pneumatic Patents November 17.

1,117,581. HYDRAULIC AIR-PUMP. **Herman E. Kruecke**, Milwaukee, Wis.

1,117,605. ORGAN-BLOWER. **Abraham J. Schantz**, Orrville, Ohio.

1,117,644. APPARATUS FOR GRANULATING MOLTEN SLAG. **Robert Donaldson**, Cleveland, Ohio.

1. In an apparatus for treating liquid slag, a trough including a plurality of stepped inclines, and means for discharging treating streams of fluid over and above said inclines to disintegrate the slag material and accelerate the flow of the latter.

1,117,679. PNEUMATIC TOOL. **Fitz James Lewis**, Empire, Canal Zone.

1,117,682. SUPPLEMENTARY AIR - SUPPLYING DEVICE FOR AUTOMOBILE-ENGINES AND THE LIKE. **Edward M. Lynch**, St. Louis, Mo.

1,117,708. VACUUM AIR-PUMP. **Paul Schou**, Copenhagen, Denmark.

1,117,911. AIR - COMPRESSOR. **James O. Rogers** and **William H. Nevin**, Denver, Colo.

13,826. (Reissue). PNEUMATIC TOOL. **John F. Clement**, Philadelphia, Pa.

NOVEMBER 24.

1,118,053. FLUID-PRESSURE MOTOR. **Montague H. Roberts**, Providence, R. I.

1,118,095. GAS PRODUCER AND COMPRESSOR. **Emmanuel Felix Aumont**, Paris, France.

1,118,183. BLOWPIPE APPARATUS. **Worthy C. Bucknam**, Jersey City, N. J.

1,118,189. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. **Lewis B. Doman**, Elbridge, N. Y.

1,118,200. HUMIDIFIER. **John I. Haynes**, St. Louis, Mo.

1. A device for the purpose described that is adapted to be used with an electric fan, said device comprising a tank for holding a bath, an

endless strip of fabric arranged to travel through said bath, and a driving mechanism for moving said strip provided with means that is adapted to be engaged by the blade of the fan.

1,118,249. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Eugene T. Turney, Rock Island, Ill.

1,118,257-8. MILKING-MACHINE. Oscar Anderson, Chicago, Ill.

1,118,261. PNEUMATIC PLAYING ATTACHMENT FOR MUSICAL INSTRUMENTS. Robert J. Bennett, Moline, Ill.

1,118,268. TRACK - DRILLING MACHINE. Charles B. Coates, Chicago, Ill.

1,118,294. PNEUMATIC ACTION FOR AUTOMATICALLY-OPERATED MUSICAL INSTRUMENTS. Richard A. Leadbeter, Detroit, Mich.

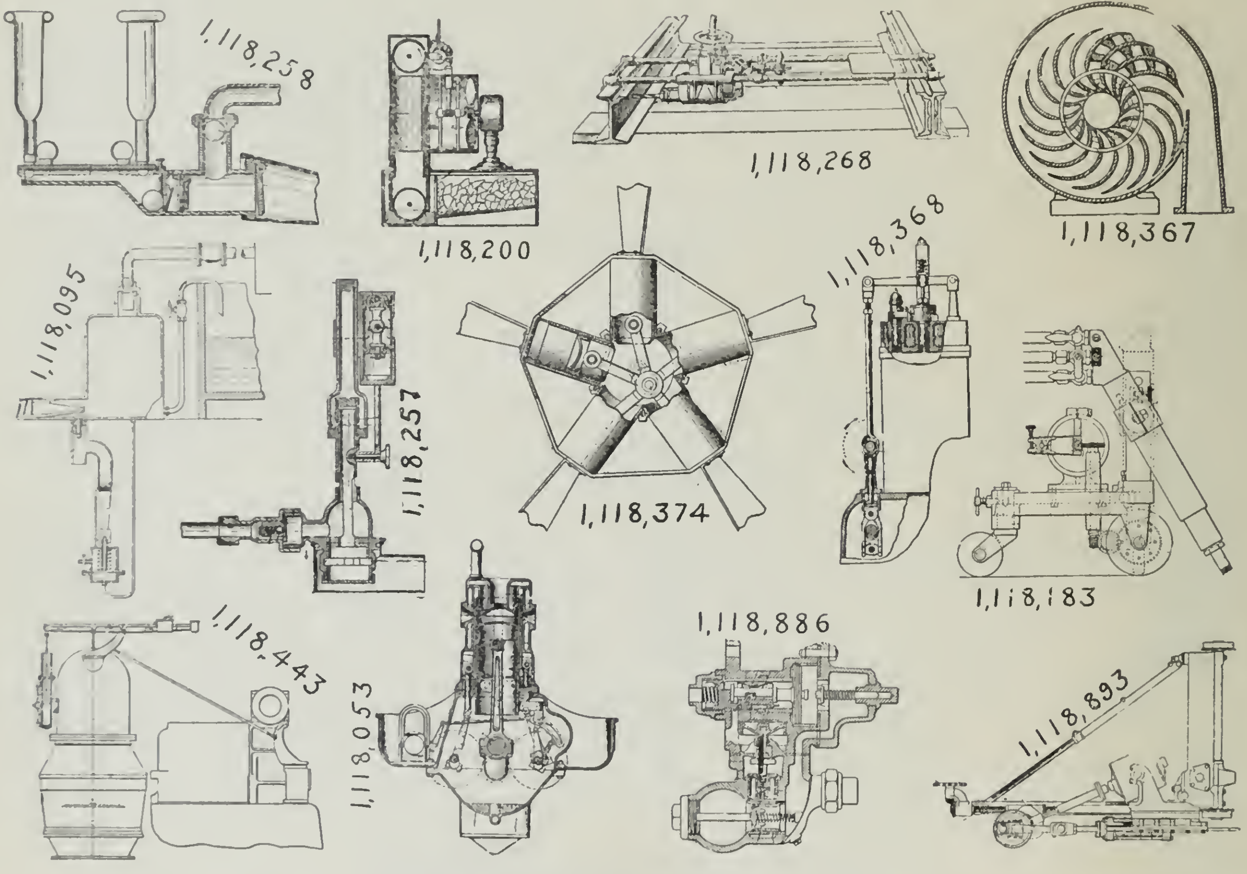
1,118,551. APPARATUS FOR FEEDING TUBES. William H. Honiss, Hartford, Conn.

1. The combination, in tube feeding mechanism, of a pneumatic gripping device for holding the tube, a movable pneumatic feeding device for advancing the tube, means for alternately operating said devices to grip and release the tube, and means for moving the said feeding device while it grips the tube.

1,118,552. PROCESS OF PNEUMATIC FEEDING. William H. Honiss, Hartford, Conn.

1,118,737. AUTOMATIC COMPRESSION REFRIGERATING APPARATUS. George P. Carroll, Bridgeport, Conn.

1,118,786. PNEUMATIC WHEEL. Joseph Laus, Jr., Oshkosh, Wis.



Pneumatic Patents November 24

1,118,297. FLUID-MOTOR AND RETARDING DEVICE THEREFOR. James F. McElroy, Albany, N. Y.

1,118,367. COMPRESSING GASES OR VAPORS. Gustav Pagel, Berlin, Germany.

1. A centrifugal gas-compressing pump of the water-throwing type, provided with a directing ring or annulus in which no transformation of velocity into pressure occurs, and a surrounding spiral casing which increases in cross-sectional area toward the point of final discharge for effecting such transformation.

1,118,368. AIR STARTING MECHANISM FOR OIL-ENGINES. Otto F. Persson, Erie, Pa.

1,118,374. FLUID - DISPLACING MOTOR. Anthony R. Silverston, Milwaukee, Wis.

1. In a device of the character described, the combination with a motor embodying a stationary member and a second member revolving about the first said member, of a plurality of propeller blades mounted on said revolving member, and means for varying the pitch of said blades on said revolving member.

1,118,443. MEANS FOR CHANGING THE OUTPUT OF CENTRIFUGAL COMPRESSORS. Richard H. Rice, West Lynn, Mass.

1,118,886. AIR-BRAKE APPARATUS. John W. Bingley, Watertown, N. Y.

1. The combination of a triple valve of an automatic air brake apparatus having an emergency valve controlling a vent passage from the train pipe and itself controlled by the triple valve piston and valves actuated thereby; with a controlling valve for the train pipe vent passage governed by variations in train pipe pressure independently of the triple valve piston and parts actuated thereby substantially as and for the purpose described.

1,118,893. TOOL-ACTUATING MECHANISM. Albert Ball and Henry H. Mercer, Claremont, N. H.

1. Tool actuating mechanism comprising a main frame, a standard rising therefrom, a frame mounted upon said standard and vertically adjustable thereon, tool holding means mounted for reciprocation upon said frame and having a fluid receiving chamber, a working cylinder operatively connected to said tool holding means and in fluid connection with said receiving chamber, a piston mounted in said cylinder, a motor mounted independently of said frame and driving connections between said piston and said motor.

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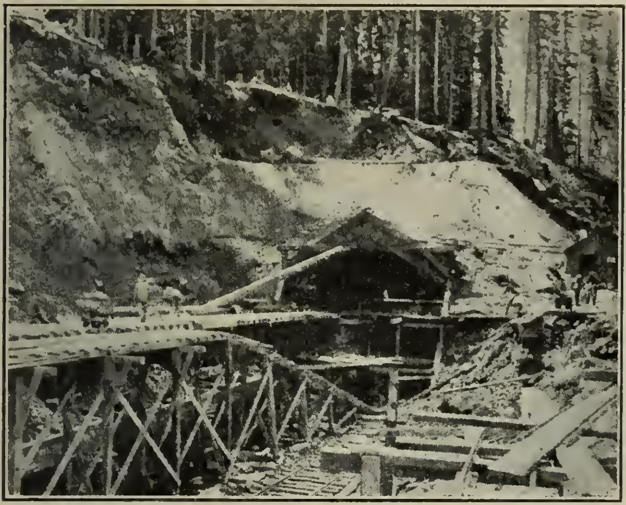


FIG. I. EAST PORTAL.

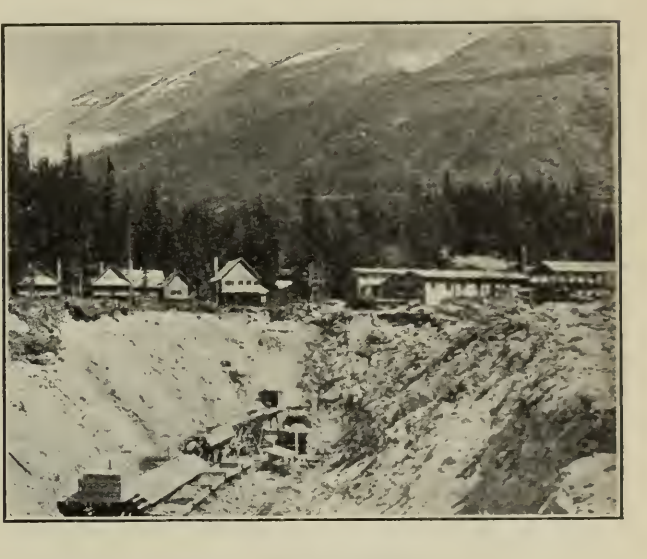


FIG. 2. WEST PORTAL.

MAKING AND BREAKING TUNNEL RECORDS

A double track tunnel five miles long is being driven through the Selkirk mountains, at Rogers Pass, B. C., for the Canadian Pacific Railway. The tunnel forms a portion of a new line construction 18.6 miles long which will bring important advantages. It saves 4.4 miles of actual distance. While it does not reduce the ruling grade of 2.2 per cent, it reduces the length of this grade from 21 to 12 miles on the east approach, and from 25 to 17 miles at the west end. It also eliminates 552 feet of rise and fall and, while the maximum curvature remains 10 degrees, there are only three such curves on the new line in place of a large number on the old line, and 2,600 degrees of central angle is eliminated. The saving in snow sheds, and also in bridges and viaducts is another important feature.

The new construction having been decided upon, the promised saving in operating four to eight transcontinental passenger trains and a dozen through freight trains daily made rapidity of construction imperative, and, as all depended upon the tunnel, time limits were set the contractors with large bonuses for quicker completion.

The tunnel will be one with records of its own in more than one particular. It will be the longest tunnel on the American continent, being more than a quarter of a mile longer than the Hoosac tunnel; also, as will appear, in driving the main tunnel in this case, neither the top heading method, most familiar in American practice, nor the European bottom heading is used, but instead a central heading is driven first with a breaking of the rock all around this center for the full tunnel section.

Another record for this tunnel work is the building of a pioneer parallel tunnel at the contractor's expense with crosscuts into the main tunnel, thus giving more faces to work at, greater facilities for removing the spoil and the general avoidance of the usual delays. That it was a wise expedient the result already shows. By this method work can be pushed from several faces at once without interference. It is possible also to do all blasting ahead of the shovels, so that they can be operated continuously. Air lines are carried through this pioneer tunnel where there is only slight danger of their being broken; all drainage is removed by the same outlet, that at the west or up grade end being handled by booster pumps, with a portable pump on wheels at the face of the heading.

The construction work was actually begun September, 1913, and it was estimated that by the ordinary methods it would require four years to complete the job, and it appears at the present writing that at least a year of this construction time will be saved.

The pioneer tunnel is 6½ by 9 ft. in section, and is driven from each end, not so that these will ultimately meet, but each about 50 ft. to the right of the main tunnel, and with the floor 7ft. above the final grade. Cross cuts are driven to the center of the main tunnel at intervals of about ¾ mile, and center drifts 11 by 8 ft. are then driven up grade on the center line of the main tunnel, with the bottom of these drifts also 7 ft. above the final grade. The rock is then driled and broken on all sides of the drift, and after shooting the material is loaded by air operated shovels into small cars and removed through the pioneer tunnel. Muck will not be brought out through the pioneer tunnel portals after the full tunnel section has advanced beyond the first crosscut, as the ½ yd. dump cars from the pioneer base can then dump most conveniently into the 12 yd. cars used to serve the steam shovel.

The operations being identical at each end of the tunnel complete duplicate power plants have been installed. At each end ventilation is provided by a Connersville ventilating fan, with a capacity of 3,000 cu. ft. of air per min. This air is delivered through the pioneer tunnel to the various fans in the main bore end to the pioneer heading. A second fan located near the portal of the pioneer heading assists in drawing the foul air out from the fans.

Two Ingersoll-Rand compressors with capacities respectively of 2,200 and 1,100 cu. ft. of free air per min., provide the power for operating drills, shovels and other tools working at 110 lb. pressure. A third compressor with a capacity of 750 cu. ft. compresses air to 1,000 lb. for operating the 16 ton locomotive used in hauling the muck. A similar locomotive, but weighing only 10 tons, is employed at the east or down grade end of the tunnel. All of these various units at each end are driven by five 150 h.p. coal fired boilers.

The rock so far has been schist, slate and quartzite, and it is expected that no other material will be found. The quartzite is extremely hard and drilling progress is slow, although it is advantageously broken up by the powder. The schist, which seems to predominate so far, is comparatively easy to drill, but is so tough that a second shooting is nearly always required.

The full section will be drilled from the center heading by piston drills, but on the pioneer bore, where speed is the primary consideration, Leyner-Ingersoll drills, using 1⅛ in. steel are used exclusively. Leyner drill sharpeners are used with oil furnaces, this fuel being found more economical for the purpose than coal. The shanks are tempered in oil and the bits in water. In the pioneer heading three drills are mounted on a bar, and holes are sunk to a depth of 6 feet. The rounds each have from 22 to 28 shots, and four rounds are usually fired for three eight hour shifts, although five rounds and even six are sometimes fired within the same time. There is no cessation of the work for a minute, day or night or Sunday.

A NEW TIME RECORD.

As might have been expected from the special inducements in the case, the arrangements which these stimulated and the up-to-date apparatus employed, unusual progress is being made in this work. In July, 1914, 715 ft. of pioneer heading was driven at the east end alone. For November, 1914, the advance was as follows:

East end main center heading.......	588 ft.
East end pioneer heading	529 ft.
West end main center heading......	654 ft.
West end pioneer heading	817 ft.

The last figure given is believed to be the American record of tunnel progress. This pioneer heading was driven down grade through rock that could not be broken over 6 ft. per round. The best day's advance was 37 ft.

In Fig. 2 the advance day by day is plotted to include Dec. 1, which gives a total advance of 852 feet for 31 days. For the 31 days comprising the month of December the advance was 852 ft.

The entire line construction is being done for the Canadian Pacific Railway, of which J. G. Sullivan is chief engineer; F. F. Busteed, in charge of construction, British Columbia division, and J. W. Sheppard, assistant engineer in charge at the tunnel. The contract for the tunnel is held by Foley Brothers, Welch & Stewart, for whom A. C. Dennis is superintendent and T. Truran master mechanic. J. Murphy is assistant superintendent in charge at the east portal and J. Fowler assistant superintendent at the west end.

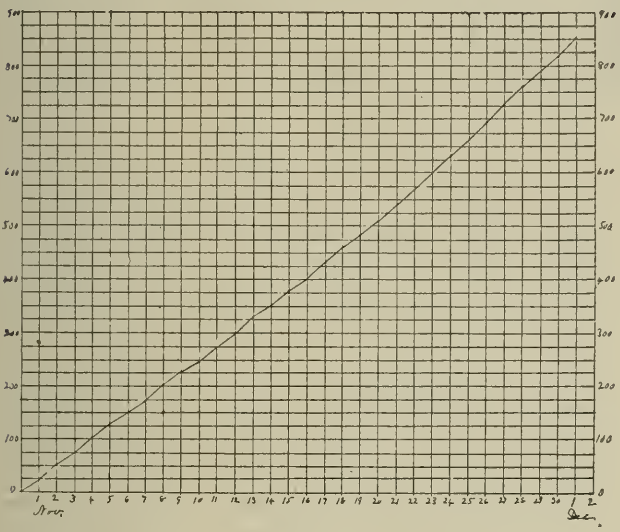


FIG. 3.

THE HIGHEST AND LOWEST TEMPERATURES IN THE ATMOSPHERE

The classic example of extreme hot weather is the temperature reading of 127.4 deg. Fahr., recorded at Ouargla, an oasis in the Algerian Sahara, on July 17th, 1879. It must not be supposed, however, that this is the highest temperature ever known to have occurred in the atmosphere. It is merely the maximum ever measured by the shaded thermometer of a regular meteorological station. In the interior desert region of New South Wales the traveler Stuart once measured 131 degrees in the shade. Griffiths, in his "Travels in Arabia," mentions having observed the heat during land winds to reach 132 degrees in the shade, and 156 degrees in the sun. In this connection it should be remarked that readings of a thermometer "in the sun" are entirely unreliable, because the instrument is directly heated by the sunshine, and no longer records the temperature of the air around it. In the Northern Circars (India) the temperature on one occasion is reported to have stood at 108 degrees at *midnight*, and at 112 degrees at 8 A. M. Night temperatures of 100 degrees and more are common in the Arabian desert. The most extraordinary shade temperature on record is 167 deg. Fahr., said to have been observed in the Desert of Gobi, but this observation is certainly questionable.

LOW TEMPERATURES.

At the opposite end of the scale we have the famous reading of 90.4 deg. below zero Fahr. recorded at Verkhoyansk, Siberia, January 15th, 1885. This often quoted record has, however, been beaten recently at the same place, with a reading of 97.6 degrees below zero. The excessive cold prevailing in this part of Siberia in winter is the more remarkable when we consider that the same region occasionally has temperatures as high as 88 degrees above zero in summer—a range of 186 degrees! The summer is about two months long, and its hot days thaw the ground to a depth of about 3 feet. Verkhoyansk would be uninhabitable in winter, but for the fact that it never experiences much wind at that season. Another "winter cold-pole" appears to lie over Nova Zembla. A minimum thermometer left here by an Austrian expedition in 1872 was found many years later to have registered a temperature of 95.8 degrees below zero. The lowest average temperature throughout the year is found in Antarctica, though the winter temperatures here do not fall so low as those above mentioned. The minimum individual temperature reading thus far reported from the Antartic is 73.3 degrees below zero, observed by Amundsen's expedition on August 13th, 1911.

The absolute minima of temperature heretofore measured in the atmosphere were not, however, found near the earth's surface, but at an altitude of several miles, and the measurements were obtained with self-registering thermometers attached to "sounding balloons." The "record" up to date is 133 deg. below zero Fahr., and, strange to say, this extremely frigid temperature was found about 10 miles above the Island of Java, only a few degrees of latitude from the equator. A temperature of 119 degrees below zero has been measured almost exactly over the equator in Central Africa, at an altitude of 12 miles.—*Scientific American.*

A NEW ENTRY DRIVING MACHINE

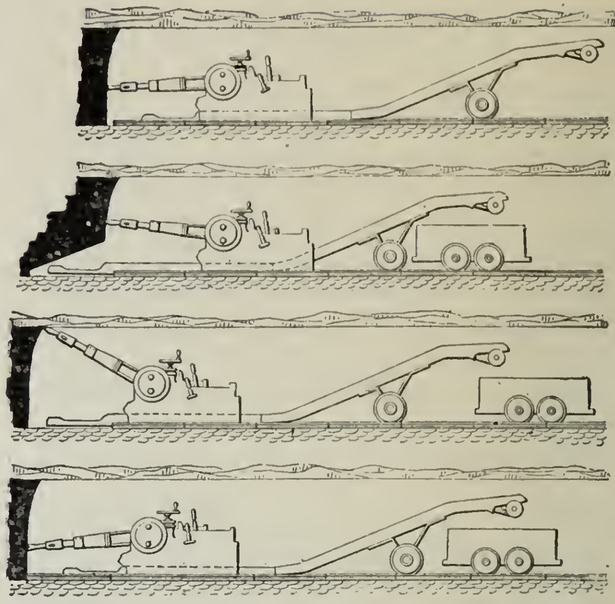
BY A. H. GIBSON.

One feature of coal mining which is admittedly dangerous and undesirable is the use of explosives. The only reason for their employment and the risk entailed when they find their way into ignorant or careless hands, is economy. If, however, their use could be entirely eliminated without decrease of output or increase of cost, and without introducing other and perhaps more grave dangers, the safety of coal production would be considerably enhanced, while the occupation of coal mining would become more attractive to the coming generation.

At the present time this improvement in means and methods is applicable to the driving of entries. It is alleged that the Ingersoll-Rand "Heading Machine," "Entry Cutter" or "Cutter and Loader," as it is variously called, accomplishes this result. The machine in question is not new, having been in existence for some six years and having cut many miles of entry. It has now, however, arrived at the status where its endurance, performance and possibilities are known quantities which can be thoroughly proven on a commercial scale.

The principle and operation of this machine may be clearly understood from reference to the accompanying drawings, Figs. 1 to 4. Fig. 1 represents the device ready for undercutting. The machine itself consists of a powerful compressed-air coal puncher mounted upon a carriage and under the control of the operator. A lever elevates or depresses the puncher pick. Another lever moves it from rib to rib by means of a small air engine, while a third lever moves the whole puncher together with its truck bodily toward or away from the face, the conveyor remaining stationary within certain limits or accompanying the forward or backward motion of the puncher as desired.

The puncher itself makes about 160 strokes per minute, and is controlled in the same manner as the ordinary hand-operated machine going from rib to rib and making a cut extending the entire width of the entry.



FIGS. 1, 2, 3, 4.

The conveyor is driven by a separate engine suitably controlled by a stop valve, and the mine car is filled evenly by moving the same about three times during the loading process by means of the brake on the car, provided the latter is on a sufficient grade, that is, on the dip the car is stopped at the proper place to fill the end nearest the machine first, after which the brake is released, allowing the car to move down hill until the loading is complete.

Fig. 2 shows the machine and entry after undercut is finished, and the conveyor moved into the kerf. This illustration also shows an unfilled car in place and in readiness for the process of knocking down the coal, the car being shown as it would be placed when working on the rise. Making the undercut is the longest part of the operation, requiring from 25 to 40 min., according to the hardness of the coal.

Fig. 3 shows the knocking-down process completed. This ordinarily takes place faster than cars can be supplied. The next operation is to pull the conveyor back about 7 ft., lay a section of track, and move the conveyor forward to position.

Fig. 4 is the same as Fig. 1, except that the entry has advanced about 5 ft. and five to six cars of coal have been loaded out.

THE AVERAGE ADVANCE IS 10 FT.

Two set-ups during the shift constitute a 10-ft, advance of the entry. It is estimated that under suitable operating conditions, such as high coal of the quality found in the Pittsburgh seam, that the machine should average 250-ft. advance per month of 25 working days, working day shift only, night shift being reserved for the laying of tracks, piping, etc.

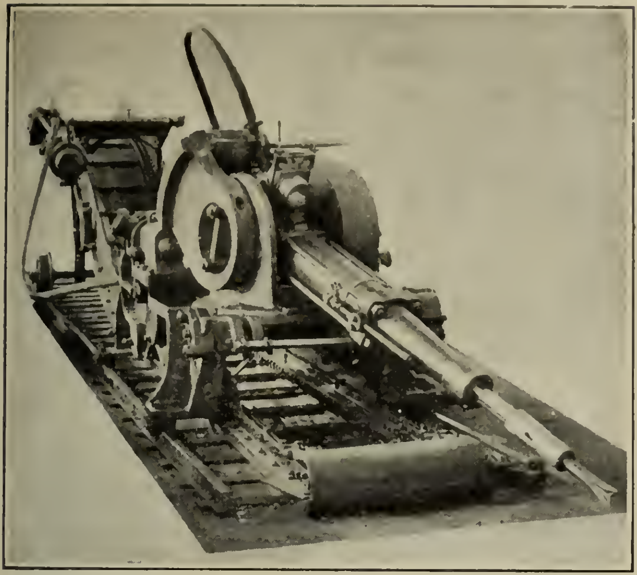


FIG. 5.

Under actual working conditions, the advance made and the repairs show such a speed to be perfectly possible.

Two of these machines which have been in operation at the Annabelle Mine, of the Four States Coal & Coke Co., at Worthington, W. Va., have been in operation since June 1, 1913. These have been operated two shifts of nine hours each per day, and entries cut averaging 10½ to 11 ft. wide and 6½ to 7 ft. high. Where conditions have been suitable and cars have been served to the machine without delay, as much as 20-ft. advance has been made in a single shift. This condition does not, however, hold true all the time, as the machines are considerably delayed by lack of cars, but the average operation over a period of two or three months showed a progress of somewhat over 10 ft. per shift on the average.

The question naturally arises, how does this machine compare with present costs of entry driving? According to conditions, comparisons will vary somewhat, but taking into consideration the first cost of the machines, which work in pairs, the total actual daily expense figures out favorably to the machine, everything being considered. This estimate, however, does not take into account the increased rate of entry driving, the reduced risk of gas or dust explosion, due to the absence of explosives, the fact that a straighter entry is secured, that the roof is better since there is no blasting to shake it loose, also that the ventilation is better due to the straight sides and roof facilitating the movement of the air current.

A reduced risk of explosion is secured by the absence of electric arcs or sparks, and the much ridiculed but nevertheless real menace of live wires strung along the entry, which are, even under the best circumstances, a more or less imminent peril to both men and animals. The advantage of this machine is still more apparent where the roof is bad and requires timbering.

With this, as with other pneumatic mining machines, where gas collects in the entry over night, a small quantity of air may be allowed to escape from the pipings nightly, with the result that in the morning there is no gas and the air at the face is clean and fresh.

SPACING OF BREAKTHROUGHS MAY BE GREATER.

Owing to the ventilating effect of the exhaust air from this machine and the fact that

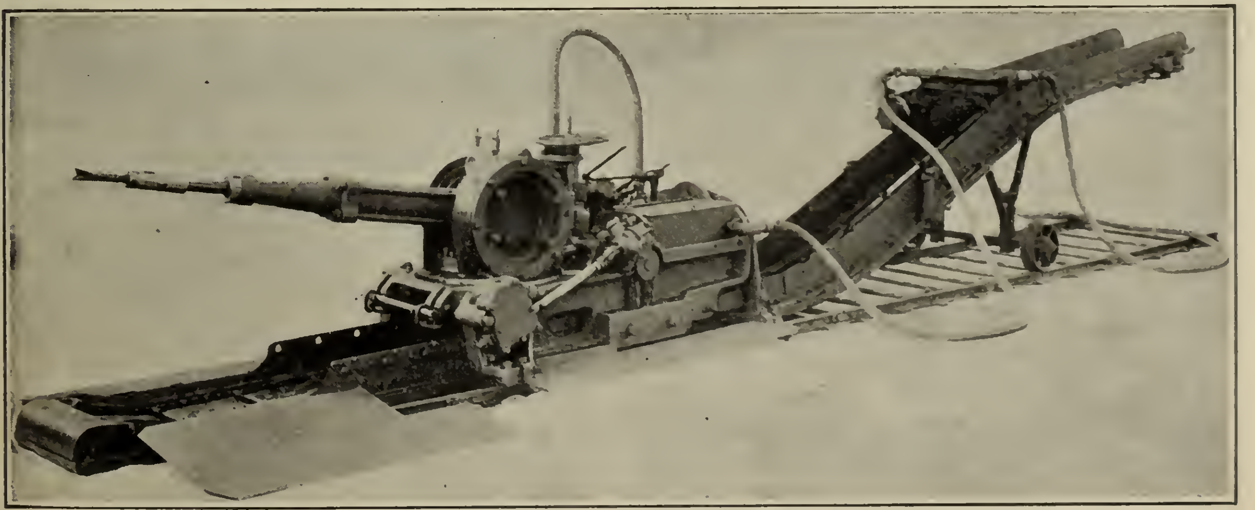


FIG. 6.

this exhaust takes place while work is being done, the distance between breakthroughs prescribed by law could be doubled without seriour danger. This fact reduces this expensive deadwork about half, and allows the entries to proceed more rapidly.

The use of this machine renders possible the working of coal mines by the retreating system, which, should it become general, would effect a considerable saving of human life due to the reduction of accidents from falls of roof. Its use also secures greater uniformity and reliability in daily output than is at present common.

This machine has the disadvantage that when working on the rise a water supply is necessary, which has to be piped to the machine in the same manner as the air line twice each week. The water jet and a beam of light from a safety electric headlight follow the movements of the coal pick, both spray nozzle and headlight being mounted upon the plunger frame and moving with it. Where the entry is on the dip, the coal is usually wet and requires no water spraying.

As has been stated above, this machine has been in operation for about six years. It is, however, only now being placed upon the market. In the operation of the earlier machines, failure and breakages were frequent, and it was found expedient to redesign practically everything on the whole device, after which it was necessary, considering the previous experience, that the redesigned machine should continue for a considerable period of time in operation, to prove beyond doubt that it would stand up to continuous work cutting and loading coal. The success or failure of any mechanical coal cutter depends largely, if not entirely, upon its reliability of operation.

The present machine with its embodied improvements and simple working parts has gone through a severe development, resulting in a steel-inclosed, grease-packed construction, the wear upon which is bound to be extremely small. In the course of driving the several miles of entry in the various mines which this machine has cut, nothing has stopped its advance. Horsebacks have been cut through, large lumps of sulphur have been removed, the entry has been driven under treacherous roof, curves have been cut, and headings as wide as 13 ft. have been made. The machine has also been used in cutting breakthroughs, slate has been cut down and loaded! No accidents have occurred, although the work has been done in gaseous mines with gas issuing from the face most of the time. It is believed, therefore, that compared with the usual method of entry driving, namely undercutting and shooting down, the employment of this machine renders the work at once faster and safer.—*Coal Age.*

SUCTION CONVEYANCE FOR CAST IRON CHIPS

The removal of chips from cylinder-boring machines by the use of suction, or vacuum, is an interesting development in the shops of the Continental Motor Co., of Detroit, Mich., which has been assisted in this work by the American Blower Co., also of Detroit. About six months ago, they installed a No. 3 type-P exhauster to remove chips from two of their cylinder-boring machines. With a six-cylinder automobile engine in place for boring, two aluminum hoods are placed over the valve ports and the chips are drawn through 2½-in. pipes to a separator. This separator is a particularly interesting feature of the installation, as the chips are not carried through the fan but are removed here, where they are at all times easily accessible for cleaning. It is nothing more than a home-made steel-plate box, in the form of a 20-in. cube, arranged with a large horizontal slide in the center, so that it can be divided into two compartments. By closing the slide, the lower half of the box can be emptied while the upper half remains available for collecting chips without interfering in the least with the operation of the system. A 5-in. pipe runs from the top of the box into the main line, which connects with the fan.

This system was designed to handle a maximum of 15 lb. of chips per min., each boring machine having a normal capacity of 6 lb. per min., the additional capacity being allowed for necessary speeding. The velocity through the 2½-in. pipe is approximately 12,000 ft. per min., while the velocity through the 5-in. pipe, which exhausts from the top of the box, is 4,000 ft. per min. The fan runs at 3100 r.p.m. and handles approximately 1200 cu. ft. per min., against a static pressure of 17 in. of water, requiring about 7½ b.hp. to drive This is proving very satisfactory, and there seems no reason why there should not be quite a field for this kind of work.—*Am. Machinist.*

A NEW VOLUME REGULATOR FOR AIR COMPRESSORS

BY RAGNOR WICKANDER.*

The ordinary reciprocating type of air compressors and blowing engines has a displacement proportional to its speed, and the quantity of air pumped varies approximately in the same proportion. In most cases, however, it is desired to regulate the amount of intake air so that it will correspond as nearly as possible to the amount of compressed air consumed, thereby keeping the pressure in the receiver practically constant. A number of regulators, governors or unloaders have been designed for this purpose and the object of this paper is to present a new method serving the same purpose as these devices in a simple and efficient manner, and to demonstrate the principle upon which this method is based.

The operation of this regulator is based upon the following principle: The pressure acting upon and tending to close a suction valve held open by force during the discharge stroke of an air compressor, is proportional to the air pressure created in the cylinder and varies during said stroke, as shown in Fig. 1.

This diagram was taken on a 24 by 14-in. air compressor operating at 50 r.p.m. The valve area of the suction valve, which was held open by force during the discharge stroke, amounting to about 3.5 sq. in., and the average speed of flow of the air through this valve was therefore about 15,000 ft. per min. It is interesting to note how the cylinder pressure increased practically in proportion to the part of the stroke made by the piston.

From this diagram it can be assumed that a closing of the suction valves at an adjustable point of the discharge stroke would be obtained simply by a very gradual regulation of the force holding them open against the action of their springs, and experience corroborates this assumption. In a similar manner a closing of the automatic discharge valves at an adjustable point of the suction stroke can be obtained by the gradual regulation of a force holding them open against the action of their springs.

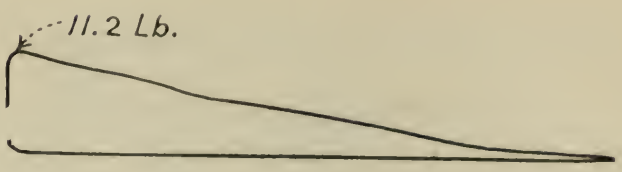


FIG. 1.

In the first case the force is so regulated that the suction valves close when the amount of intake air remaining in the cylinder has decreased to correspond to the amount of compressed air desired at the time. In the second case the force is regulated in a way to keep the discharge valves open during such a part of the following suction stroke that the amount of compressed air returned into the cylinder, after expansion to the intake pressure, will leave sufficient room for the desired quantity of fresh air to enter the cylinder during the latter part of the suction stroke.

REGULATION BY ACTION OF THE INLET VALVES.

An application of this regulator to an ordinary poppet valve air compressor, acting upon its inlet valves so as to keep the receiver pressure constant, is shown in Fig. 2. *A* is the compressor cylinder. The inlet valve *B* is provided with a spring which tends to close it, and above is a piston *C* acted upon by pressure from the auxiliary tank *D*. This valve communicates with the atmosphere through the leak *E*; and it also is connected with the main reservoir *F* through the port *G*. This port is closed by means of the pilot valve *H* when the force of the adjustable spring overcomes the air pressure acting on the bottom of the valve piston *I*. An adjustable needle valve *J* can be arranged so as to obtain a constant leak from the main to the auxiliary reservoir, thereby preventing the pressure in the latter from decreasing below a certain valve.

When the compressor is working at a constant partial load the valve *H* will allow some air to enter the auxiliary tank *D*, and the same quantity of air will escape through leak *E*, thereby keeping the pressure in the auxiliary tank acting upon the piston *C* constant. The suction valves will close at such a point of the discharge stroke as to compress exactly the quantity of air consumed, the pressure in the main tank remaining constant.

And increase (or decrease) in the consumption of air will cause a slight momentary decrease (or increase) of the pressure in the

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*Abstract of Paper presented at December, 1914, Meeting of the American Society of Mechanical Engineers.

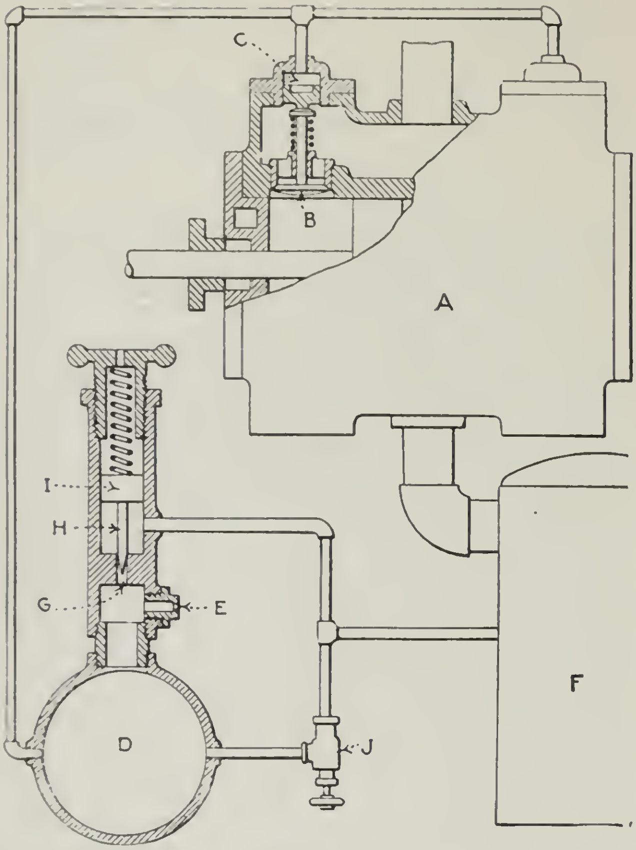


FIG. 2.

main tank, and the quantity of air entering the auxiliary tank, thereby decreasing or increasing the pressure in the auxiliary tank and changing the cut-off of the inlet valves so as to increase or decrease the amount of intake air until new conditions of equal supply and consumption of compressed air at the same pressure as before are established.

For a certain pressure in the auxiliary tank the air compressor will work at its maximum capacity, and the function of the adjustable needle valve is to admit constantly so much air as to produce this pressure. If more air be admitted the capacity of the compressor will be reduced, and the volume of the intake air will vary with the consumption only as long as the latter remains below this reduced capacity.

REGULATION BY ACTION OF THE DISCHARGE VALVES

Fig. 3 shows the application of the same principle to the regulation of the discharge valves of an aid compressor of the piston inlet type. The action of the device is similar to that represented in Fig. 2, and will be easily understood in referring to the drawing.

When the compressor is working at a constant partial load the air under pressure from the main tank will enter the chamber *K*, and counteract the tendency of the spring to force down the piston *I*. This piston carries the needle valve *H*, which closes to such an extent that the air enters the auxiliary tank *D* through the passage *G* at the same rate as it escapes through the leak *E*, thereby keeping the pressure in *D* constant. This pressure acts upon the cylinder valve *L* through the opening *M*. Under these conditions the pressure in the auxiliary chamber will be somewhat less than that in the main tank and in the passage *N* leading from the cylinder *O* to the main tank.

Owing to the low pressure thus created in the plunger *P*, the discharge valves will be kept open during part of the following stroke, and allow a certain amount of compressed air to re-enter the cylinder from the outlet passage *N* and expand in the cylinder to intake pressure. During the remaining part of the intake stroke the amount of fresh air drawn into the cylinder will exactly correspond to the consumption of compressed air at the time, and the air pressure in the main tank will remain constant.

Assuming now that the consumption of compressed air is increased a slight momentary drop of pressure in the main tank will result. The spring will overcome the effect of the

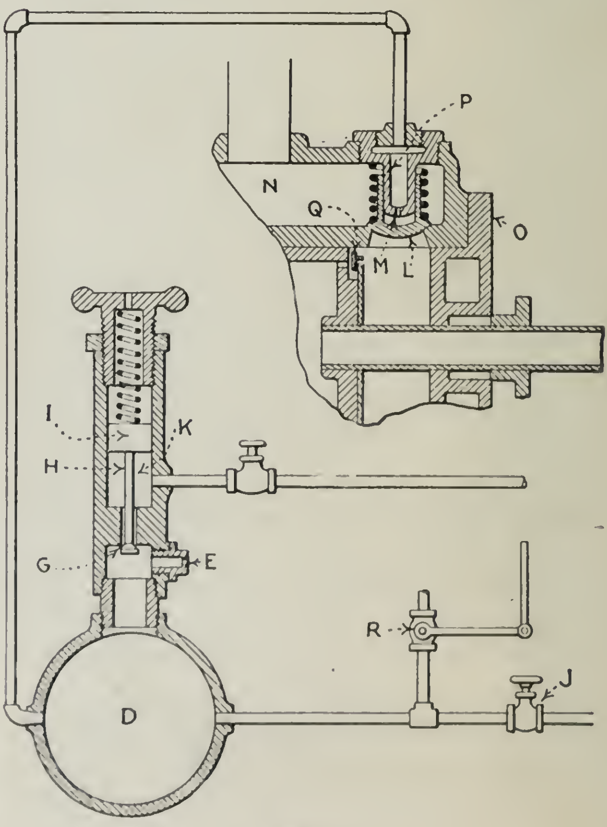


FIG 3.

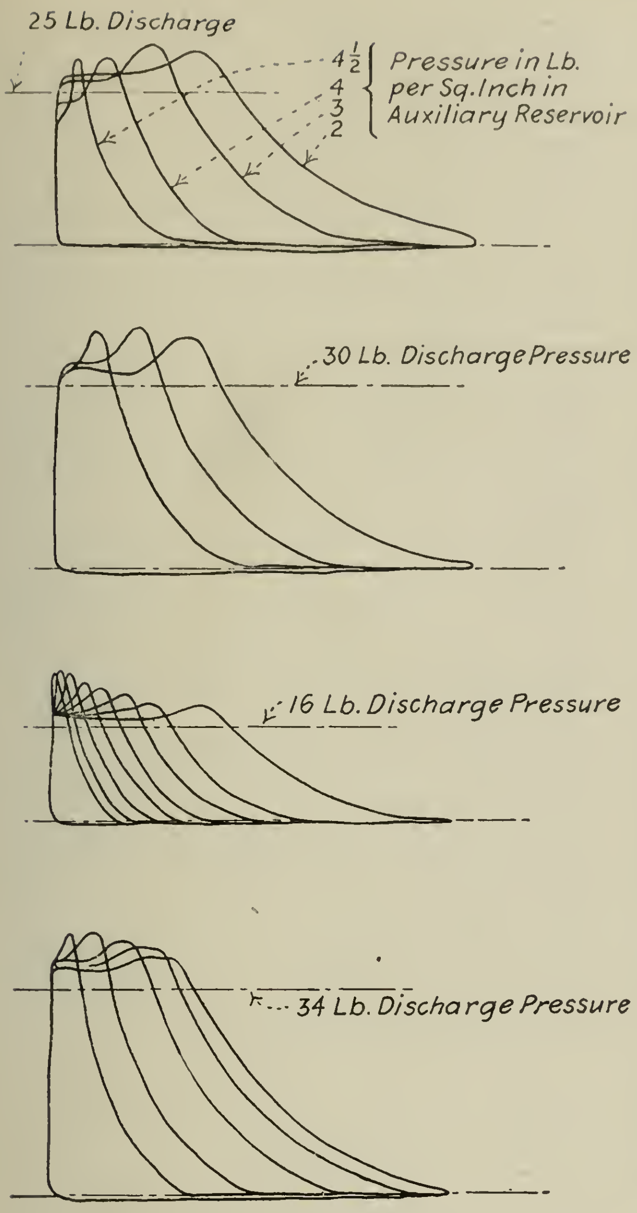


FIG. 4.

tank pressure on the piston *I* and will cause the valve *H* to open, thereby permitting a greater quantity of air from the main tank to enter the auxiliary chamber. The pressure in the auxiliary chamber will increase, and acting through the plunger *P* and the opening *M*, will cause the valve *L* to seat at an earlier point of the intake stroke, thereby increasing the volume of fresh air drawn into the compressor through the intake valve *Q* until it equals the increased consumption of compressed air taken from the main tank, the pressure in the tank being kept therefore exactly the same as before. In case of a decrease in the consumption, similar action will take place and a new equilibrium between supply and consumption will be established after a slight momentary increase of the tank pressure.

A needle valve *J* allows enough of the pressure air contained in the auxiliary tank to escape to the atmosphere, so as to unload the compressor by hand if desired. Valve *R* is opened by means of a speed regulator, if the speed of the prime mover falls below a certain value and it is desired to unload the compressor in that case.

For single or tandem compound steam driven compressors this device can easily be operated in connection with the ordinary speed and pressure governors, acting upon a throttle valve on the steam inlet, so as to regulate the output of the compressor between full capacity at its maximum speed and no volume at the lowest speed of the machine. On account of the perfect regulation which can be obtained by this combination it will in many cases be found advisable to use the cheaper single compressors instead of the duplex machines.

Fig. 4 shows a number of indicator cards taken on a standard *H* all poppet valve air compressor with by-pass equipped with the volume regulator shown in Fig. 2.

SALVAGE OPERATIONS ON THE EMPRESS OF IRELAND

In Compressed Air Magazine, Nov., 1914, page 7409, we gave an account of this interesting work. The following additional information comes to us through the *Scientific American*:

Probably no sunken wreck has presented a more difficult task for the salvors than this ship. Originally, the Canadian government employed a Canadian organization which made use of facilities developed by Mr. William Wallace Wotherspoon, the well-known salvage expert. The latter personally attended to the work, and was a potent factor in its success, although the fullest credit must be given to others, and acknowledgment must be made to the splendid services rendered by the British naval divers who assisted in the hazardous tasks of recovering the bodies of the dead as well as the mails and the silver bullion stored in the specie room.

At the particular point on the St. Lawrence where the "Empress of Ireland" went down the water is quite 138 feet deep to the surface of the soft mud bottom, and high tide increases this by quite 14 feet. This means a very strong current, especially at ebb tide, and imposed a working period of but 30 minutes at each slack tide twice a day. Apart from that, the water was so cold that the divers' hands soon became numb, and to protect them it was necessary to employ rubber mitts. These were of American make and thin enough to enable the diver to guide himself by his sense of touch—something upon which he has to depend very largely in deep and dark waters.

After sinking, the "Empress of Ireland" partly righted herself, then heeled over at a very sharp angle, and settled deeply into the mud of the river bed. This added greatly to the perils of the work and made especially hazardous the operations incident to getting through the steel side of the craft and following a devious route into the ship's strongroom. These efforts required that the divers should work at the very unusual depth of 160 feet inside the body of the foundered liner, and, to make them familiar with their objective, they were previously schooled by means of a cardboard model of the internal structure along their route. Further, that their risks might be lessened, flanking doorways and one wide passage were bulkheaded off in order that the men should not go astray nor their hose, lifeline, or telephone connections become entangled.

The telephone played an important part in the operations. This telephone gear was of English design, but somewhat improved by American telephone engineering practices. Because of the dangers involved, the divers worked always in pairs; and as soon as one couple came to the surface two more men were immediately ready to carry on the work. One of the best things done was that of drilling into the side of the ship and cutting an ample passageway. The men worked upon a piecework basis, and they pushed ahead so rapidly that their rate was but little short of that ordinarily deemed excellent at a shipyard and in the open air.

The salvage craft was provided with a compressed air system, and the divers received their air from storage tanks instead of from pumps, as is the common custom, and there was also a hospital or decompression tank such as is used here in the United States in foundation work for skyscrapers. The diving was carried out agreeably to the practices prescribed by the British Admiralty, after certain well-known scientific tests, and while the unusual number of twelve divers were engaged upon the job only one man lost his life. He, unfortunately, slipped from the side of the sunken liner and dropped into much deeper water. The sudden application of hydrostatic pressure confused him, and in his excitement, instead of opening his air valve, he screwed it closed, and actually broke off the little hand disk! After that fatality every valve seat was notched so that air would reach a diver in distress and keep him alive until aid could be sent to him, no matter if he did jam the valve by mistake.

All of the bodies were recovered that could possibly be reached, and this was really the prime concern of the officials of the Canadian Pacific Railway; also the bullion and specie in the strong room were salved; and up to date substantially most of the mail pouches have been brought to the surface. In addition to this, the steel masts of the "Empress of Ireland," which were a menace to navigation, were cut away with air drills. This entire undertaking marks a notable advance in deep-water salvage operations, and shows that even the dangerous conditions on the St. Lawrence will not daunt determined men when guided by thoroughly competent experts.

CEMENT A PROTECTION AGAINST SAND BLASTS

The use of cement as an anti-sand blast is possibly one that is little known. The sand blast in question, however, is not that which is so familiar to all of us, but is quite of another type. When locomotives stand under steel or iron bridges or viaducts, the blast from the stacks throws out gases and numerous small particles of ashes and coal. This when continuously projected against the overhead iron or steel gradually causes its disintegration. "When all remedies fail, try cement," and in this case cement was tried and not found wanting and now it is common practice for railroads to cover the bottoms of their bridges with wire netting or metal lath covered with a coating of sand and cement which it has been found resists perfectly the attack of the gases and also the sand blast coming from the locomotives.

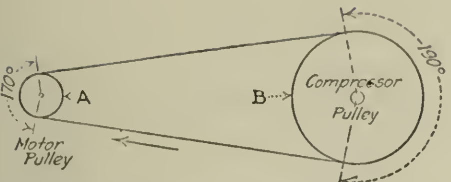


Fig. 1. Long Belt without Idler

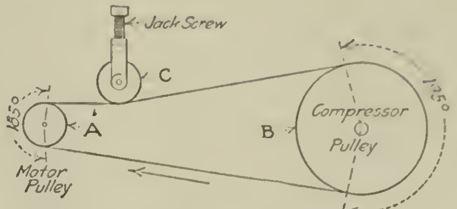


Fig. 2. Fixed Idler

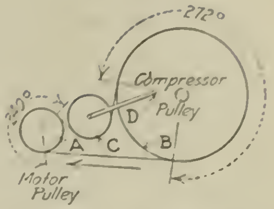


Fig. 3. Short Belt

THE SHORT BELT DRIVE

In a recent issue of *Power* Mr. W. F. Schaphorst treated of certain idlers on belt drives as though they were something new, but in fact compressor builders have long used them.

To test their efficacy, the Ingersoll-Rand Co. equipped a machine in its power house, some four years ago, and their performance was closely observed for about a year. As a result they have been adopted as standard design under the name of the "Short-Belt Electric." The compressor builder sought this means in order to solve the limited-floor-space problem, but this is not considered the only advantage, as the illustrations will show.

Fig. 1 is the ordinary belt drive, in which the distance between centers of pulleys must be sufficient to give a reasonable arc of belt contact on the motor pulley, which at best never exceeds 170 deg.

Fig. 2 is sometimes resorted to when Fig. 1 fails to work satisfactorily. A tightener pulley *C* is placed between the pulleys *A* and *B* and held firmly against the belt. This increases the arc of contact on the motor pulley to 185 or 190 deg., but it also increases the belt tension, which is undesirable.

Figs. 3 and 4 show the short belt drive. This consists of the driving pulley *A*, the driven pulley *B*, and an idler pulley *C*, which is placed on the slack side of the belt close to the driving pulley. The idler pulley is carried on arms swung from the compressor frame and is free to rise and fall, or to float on the belt.

While the idler pulley is light, its weight is sufficient to take up the slack and hold the belt against the driving pulley. When the tension on the tight side of the belt increases and lengthens the slack side of the belt, the idler pulley immediately descends, taking up the slack and at the same time wrapping the belt further around the driving pulley and giving a greater arc of contact. The belt contact is increased rather than the tension.

Most belt-transmission losses come from slippage or from excessive tension. With the short-belt drive there is no initial belt tension and but little slippage. When the motor is stopped the belt has no strain, and only the strain of the effect while in motion.

It will be seen from the foregoing that this form of drive has long passed the experimental stage.

Charles A. Hirshberg.

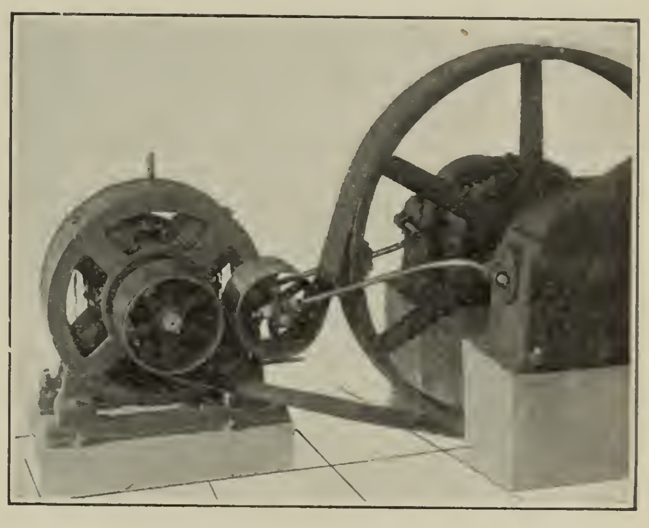


FIG. 4.

AMATEUR TUNNELING

Detectives recently discovered a number of underground passages near the belt line in Newberg, Ohio, which have been used for transferring coal from cars on the tracks to the basements of nearby houses. The passages had openings in the back yards abutting on the tracks, and these were covered by trap doors upon which piles of rubbish were usually kept to hide them. The other ends of the tunnels opened into the basements of the houses. Coal would be thrown from the cars into these back-yard openings and then would be carried through the tunnels into the basements. It is said that an entire carload of coal disappeared one night recently.

ECONOMY OF BLOCK HOLING

The tests described below, carried on by the Bureau of Mines, should interest contractors and others who have a considerable amount of boulder-breaking to do. The tests were made to determine the comparative energy expended by explosives under water and in the air, and by various methods of shooting.

The test showed very conclusively that the block-hole method of breaking boulders and large fragments of rock is very much superior to and more economical than the mud-cap or adobeshot method of breaking, which is so commonly practiced.

"Adobe shots" were made on two high-grade limstone blocks cut from the same large block and weighing 215 and 203 pounds. Each block was approximately a cube, measuring 12½ by 12½ by 13 inches. The heavier block was selected for tests in the air. It was laid on two 6 by 6-inch timbers, and on the center of the top side a 50-gram 1¼-inch cartridge of the 40 per cent. strength low-freezing dynamite was placed. A No. 6 electric detonator was inserted in the cartridge and laid parallel to the vertical bedding planes of the block. The charge was then covered with a 35-pound mud cap consisting of 30 pounds of dry fire clay mixed with 5 pounds of water and fired. The block was not shattered on top, but pieces were split off around the sides. The other block was then immersed in a barrel of water having a temperature of 70 degrees F. The water was 32 inches deep, there being 13¼ inches of water above the block. The charge was the same as in the previous trial except that no mud cap was used, and the charge was coated with paraffin in order to protect it from absorbing water. On firing no apparent damage was done to the block and no cracks were visible. This trial was then repeated on the same block immersed in water with a charge of 100 grams. This greater charge did not break up the block as much as did the 50-gram charge when the block was in air only.

Other similar tests confirming in every particular these tests, and again the confining effect of the surrounding material was shown. The above experimental proof is presented as a confirmation of practical experience that submarine blasting requires larger charges to disrupt a given amount of material than open work on similar materials.

Block-hole tests were made on two similar high-grade limestone blocks cut from the same large block and weighing 198 and 205 pounds. A hole 1 inch in diameter and 6 inches deep was drilled from the center of one side to the center of the block. Each was charged with 5 grams of the 40 per cent. strength low-freezing dynamite. A No. 6 electric detonator was used. The bore hole was filled with water in each case. The 198-pound block was fired in air and the 205-pound block was suspended in a barrel of water in the same manner as in the previous tests. Both blocks were broken. The following tabulation shows comparative results:

COMPARATIVE RESULTS OF ADOBE SHOTS ON LIMESTONE BLOCKS

Condition of Block	Quantity of Explosive used	Weight of Block	Weight of Largest Piece	Number of Pieces over 3" in Diameter	Average Weight of these Pieces	Total Weight of small Pieces
	Grams	Pounds	Pounds		Pounds	Pounds
In air	50	215	82	13	15.5	11
In water	*100	203	104	8	24.6	5

*After firing a 50-gram charge.

COMPARATIVE RESULTS OF BLOCK-HOLE TESTS WITH LIMESTONE BLOCKS

	Grams	Pounds	Pounds		Pounds	Pounds
In air	5	198	52	15	12.7	7
In water	5	205	59	11	18.2	5

It will be noticed from these figures that the quantity of explosive used when a block hole had been drilled into the rock fragment was from one-tenth to one-twentieth as large as that required by the mud-cap or adobe-shot method.

CAPE-TO-CAIRO RAILWAY

Six thousand miles, across sixty-five degrees of latitude; a score of climates and the lands of a hundred different peoples or tribes; the second longest of the world's rivers and two of its largest lakes; the greatest dam ever built, conserving water for the world's richest lands; the most imposing and ancient of all temples; the greatest waterfall, and the most important gold and diamond mines; and finally, one of the last great expanses of real wilderness, the only place in the world where the wild beasts of the jungle may be seen in their primitive state from a train, all these seen, traversed, or experienced in twelve days! Surely, there can never be another such railway as this.—*Lewis R. Freeman, in The World's Work.*

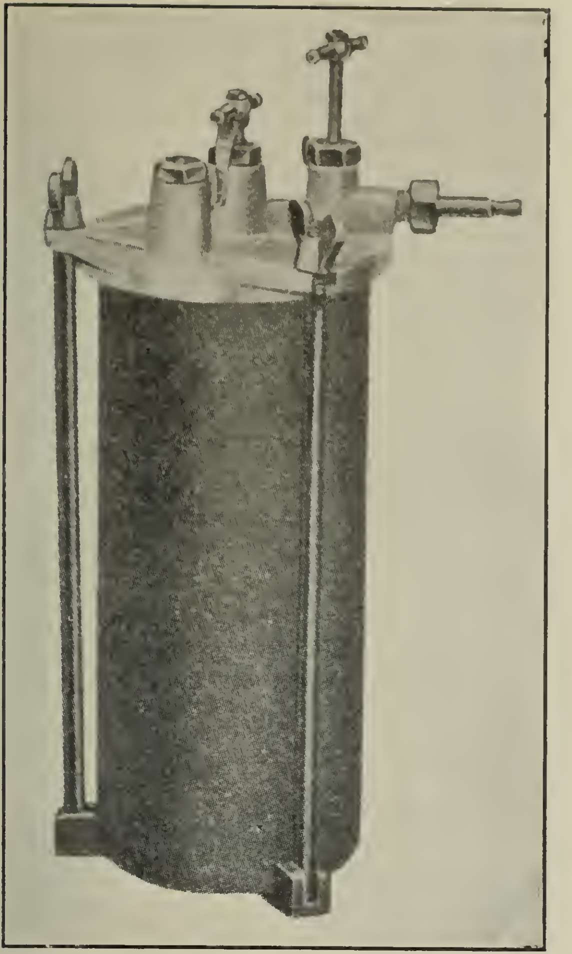


FIG. I.

A NEW ACETYLENE GENERATOR

A new type of acetylene generator which is being introduced in England by the British Low Accessories Company, Limited, is described in a recent issue of *The Engineer*. It is primarily intended for the lighting of motor cars, but there appears to be no reason why it should not be made serviceable in other directions. The makers, in referring to this generator, explain that the success which followed the introduction of electric lighting equipments has been largely due to the facility which it affords of being able to turn the lights on at a moment's notice. This, it is pointed out, is the one outstanding advantage which can be urged in favor of electricity, and, as against it may be put the considerably heavier cost of the electric equipment as compared with that of an acetylene outfit, which may be as much as many times as great.

The first step which was taken by acetylene lighting apparatus manufacturers in order to put such apparatus more on a level with electric lighting in this respect, was the employment of dissolved acetylene cylinders. By the use of these gas was always obtainable by the simple turning on of a tap. This course, however, had the disadvantage of considerable expense, and suffered from the fact that the cylinders could not be recharged at home. It was found that, however easy it might be to get spares, there always came a time when the cylinder gave out. It is to remedy this state of affairs that the new generator has been devised.

The engraving—Fig. 1—shows the new Low generator complete, and Fig. 2 shows it in part section. It may be said at first that it is not only a generator but a storage reservoir as well. The apparatus will be readily understood from the drawing. In this A is a steel drum with an open top, which is closed by a cover B, which is held on tightly by means of three screw clips, the joint being made gastight by packing C—see Fig. 1. The inside of the cylinder is coated with a substance D, which is capable of occluding or dissolving acetylene gas. This substance is, we understand, a mixture of acetone, asbestos, porous brick, and plaster of Paris. Resting

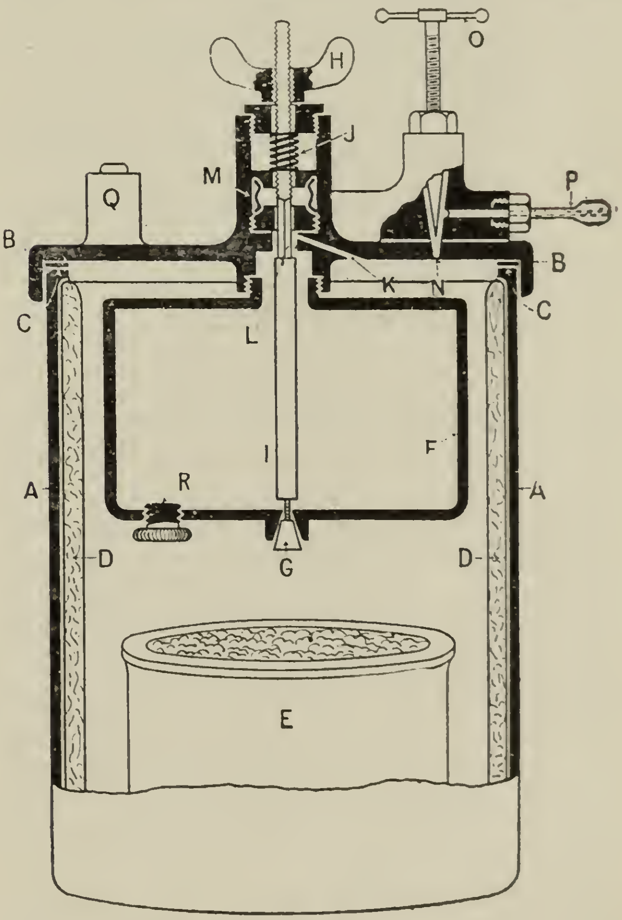


FIG. 2.

on the bottom of the steel drum is a cylinder E, for containing calcium carbide. On to this an adjustable quantity of water from the tank F can be made to drip through the valve G. This valve G is regulated by the wing nut H, acting on a screw on the spindle I, and the spring J always tends to keep it open. A gas passage K leads through the cover C to the passage through which the spindle I passes through the lid B, at which point the spindle is square, so that the gas can pass it and reach the interior of a bellows arrangement M. By this means, when the pressure of the gas in the cylinder A rises above a certain predetermined point, the bellows M expand, the spring J overcome, the spindle I raised, and the valve G closed, so that no more water can drip on to the carbide. When, on the other hand, the pressure falls, the bellows close, and the spring J again asserts itself so that the valve is opened. In this way the apparatus is automatic. It will be realized also that the gas is generated actually in the presence of the substance which occludes or dissolves it, so that even when all the carbide is used up there still remains a good deal of gas which can be drawn upon.

The outlet of the gas is at N, and this outlet is controlled by a pin valve, which is operated by the handle O working a threaded spindle. This valve allows the gas to find its way to the connecting piece P. Should the pressure, either when the pin valve is opened or closed, rise above a certain point, which depends, of course, on the strength of the various parts of the apparatus, the safety valve Q comes into operation and the surplus gas escapes to the air. It will be understood, of course, that as the pressure rises more and more gas is occluded in the dissolving material.

The generator is readily cleaned and recharged. All that is necessary is to remove the cover B by unscrewing the three wing nuts, take out the outside tin, empty clean and recharge it, sluice out the cylinder A if necessary, replace the tin E and refix the cover. It is not necessary, in order to replenish the water reservoir F, to remove it from the cap C, to which it is screwed, for water can be placed into it by turning it upside down and removing the plug P.

A number of claims are made for this apparatus, among which may be mentioned the following: (1) The gas, being dissolved, comes out dry and clean, thus ensuring a good combustion and pure light; (2) the gas being permanently stored under pressure, is delivered as soon as the cock is opened, so that lamps can be lit up immediately, and long before the stored or dissolved gas is used up fresh gas is being generated from the carbide to keep up the pressure; (3) as soon as the cocks are shut nothing can waste; the gas can be stored for years without deterioration, and will always be available at any time during that period; (4) there is no chance of explosion, and a light can be held in safety all around the generator itself; and (5) that nothing can get out of order.

ABOUT SUBMARINE MINES

A floating mine is not intended to drift about, but is put down with an automatic mooring apparatus, so that the limits of an area strewn with mines may be fairly definitely known once the sowing has been discovered. Occasionally a mine breaks loose and drifts about, but this is not the intention of the mine planters. Mines do not float in sight, but are moored to keep at a certain level below the surface. It is also intended that they should strike the most vulnerable parts of war vessels, therefore they are placed deep enough to miss the armored belts of such. The average size of mines is from four to five feet in diameter and they are charged with high explosives. The idea that a mine explodes through the force of a ship striking it is erroneous; tilting it from an upright position explodes it.

The operation of sweeping for mines is carried out by two ships steaming parallel with one another at some distance apart with a wire rope between them, sunk low enough to come in contact with the cables to which the mines are moored, which has the effect of tilting them over and causing them to explode. The danger of this operation is in the possibility of the ships themselves coming in contact with a mine, but there is no danger from the explosions of the mines by sweeping. Even a distance of 100 yards from a mine when it is exploded secures perfect safety to any vessel, as the cushion of water takes up the shock. Very light draft vessels are always chosen for this work, so that they have a good chance of passing over mines sunk deep enough to damage ships of war.—*Marine Journal.*

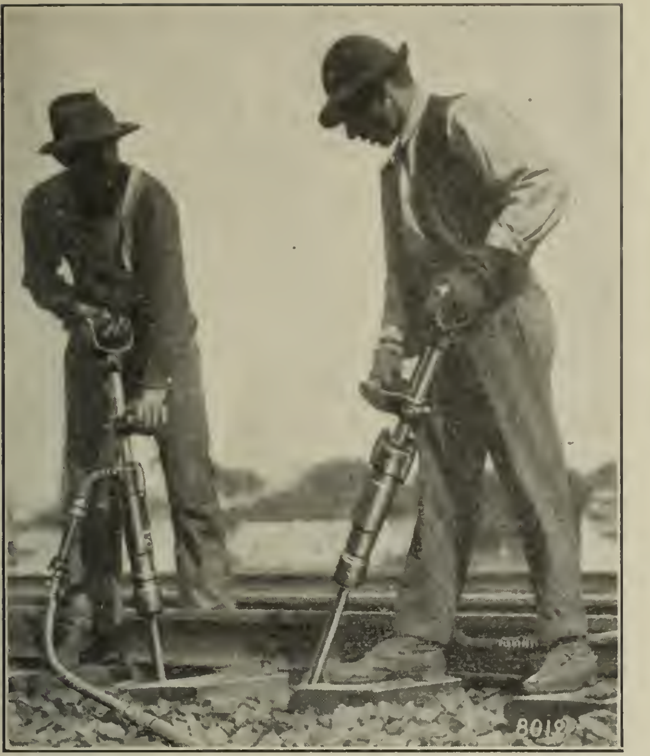


FIG. I. TAMPERS AT WORK.

PNEUMATIC TAMPING OF RAILROAD TIES

Compressed air is being used successfully for tamping ties on a part of the New York Central & Hudson River Railroad. The tamping outfit consists of two pneumatic tampers, 600 ft. of ¾-in. hose and an air compressor mounted on a hand car. The compressor is driven by a gasoline engine, which also propels the car itself at a speed of from 12 to 15 mi. per hour. The car will carry twelve men and is equipped, as one of the illustrations shows, with cross trucks, with the aid of which four men can remove the car from the track in less than a minute.

One of the illustrations shows the two tampers in use, with one man for each. Each tamper is fitted with a tamping bar of the ordinary shape, and weighs, complete, 37½ lbs. It is stated that the machine is equally effective for stone, gravel or cinder ballast, that it can be worked to advantage around frogs and switches where hand tamping is difficult or impossible, and that trackmen prefer it to the tamping pick or the tamping bar. A performance record kept on one of the units through the entire season of 1913 showed a tamping cost of 2.6 cents per tie with the machine, as compared with from 10 to 20 cents by the hand method. The record also showed that two men can average 300 ties per day.

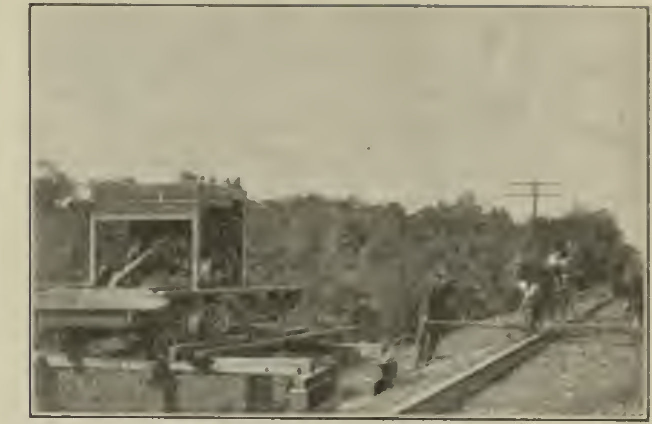


FIG. 2. SHOWING COMPRESSOR CAR.

A service test was made some time ago to determine the comparative stability of track tamped by hand and that tamped pneumatically. A section of track on the West Shore Railroad in the Hackensack Meadows in New Jersey was selected, where the foundation is soft and it is difficult to maintain the track in good condition. An 800-ft, stretch of track was tamped by machine and an equal length by hand. After six months observations showed settlement as given in the accompanying table.

TRACK SETTLEMENT IN INCHES AFTER HAND AND MACHINE TAMPING.

	Greatest.	Least.	Avg.
Hand tamping	0.116	0.018	0.067
Machine tamping ...	0.063	0.004	0.033

The compressor cars and pneumatic tampers are manufactured by the Ingersoll-Rand Company, of New York City. The New York Central & Hudson River Railroad now has twelve outfits in service.

EFFICIENCY IN MICHIGAN COPPER MINES

Unlike the Lake Superior iron mines, where "efficiency engineering" has received only fitful encouragement, the Lake Superior copper mines have given it careful and systematic attention for several years. In fact, the zeal of the copper companies for efficiency engineering became possibly a little too absorbing; for it is no secret that it was one of the indirect reasons for the long and costly Lake Superior strike. Two or three years ago, it was rumored around Lake Superior that the new efficiency campaign in progress with the Calumet & Hecla companies would save them half a million dollars or more per year. The cost of driving had been reduced 30 to 40 per cent. and the cost of stoping 10 to 20 per cent. At the same time, apart from the attitude of the miners who did not take kindly to the efficiency methods, the thorough tabulation of rock drilling and mining methods brought to light by the campaign were interesting. An outsider would be surprised at the detail with which the art of rock drilling was studied. For instance, the operation of cranking back a rock-drill on its feed-screw, performed three or four times for every hole drilled, was found to take a certain number of seconds under ordinary conditions. But when the crank handle was fitted with an iron ring or flywheel (like that on a large ice cream freezer), 8 or 10 inches in diameter, it was found that cranking back took several seconds less each time. With such a flywheel, given a few swift turns, a well greased rock-drill would nearly screw itself back. In a small mine such a detail would, of course, not be worth bothering about, but with several thousand men of the Calumet & Hecla companies, it was considered worth while. In the experiments using compressed air of different pressures for running rock-drills, it did not always make a drill operate faster or hit harder to increase the air pressure. For instance, one drill of certain make and with a certain kind of valve, drilled faster with air at 70 lb. pressure than with air at 85 lb. Other rock-drills required the high pressures for best working. One drill could not stand too much air at once, and worked best with the air inlet cut down to ½ in. Water in the compressed air affected some rock-drill valves badly, and made them freeze; another type rarely froze. Rock-drills with a "short-stroking" attachment were desired, not only for convenience in "fitchered" holes, but for using drill-steels slightly too long for the full stroke, as often happens in changing steel, and for general desirability in starting holes. The attention given to setting up a column with its swinging arm and saddle, was also very close and several small mechanical appliances were invented to hasten that part of the miner's work. Another feature adopted by some companies is the use of ⅞-in. drill steel in place of 1⅛-in., which reduces the area of the drill holes so that with less rock to cut, the cutting goes faster, requiring, however, higher per cent. dynamite in narrower sticks. On the South Range, where the Copper Range Con. mines use the "dry-wall" method of stoping (the lodes are too flat for it as Calumet), tailing from the stamp-mill is brought back in the ore cars and piped and blown by compressed air into the stopes for standing on to reach the back, in this way eking out the waste rock ordinarily used to stand on as a result of the sorting underground. It was formerly necessary to tap old stopes for additional waste or to blast it from the walls, which methods were expensive, especially the latter.

In 1909, when two-man drills were in use, the average driving per man per shift was 0.7 ft. for the Superior mine (as well as approximately for the entire copper country). In 1911, when the Calumet & Hecla had introduced one-man drills and efficiency methods in its Superior mine, where these innovations were first given trial, that mine raised this figure to 1.2 ft. per man per shift, and a little later to 1.5. Since then all the Calumet & Hecla companies have introduced the methods tried out in the Superior, as have most of the other operators also, and nearly as startling gains in efficiency have been made as was the case in the Superior.—*Mining and Scientific Press.*

IMPORTANT PATENT SUSTAINED

In the construction of the foundations of many of the great buildings of more recent erection in lower Manhattan, caissons have been sunk close together, all around the space built upon, and these caissons have finally been so joined together as to form a watertight enclosure. A patent embodying this system was issued to John F. O'Rourke, July 16, 1901, and this patent has been sustained in a decision by Judge Learned Hand, Dec. 31.

The O'Rourke Engineering Construction Co., brought suit against The Foundation Co., for infringement of the above patent. The defendants claimed that the construction described in O'Rourke's patent was anticipated by the method of construction adopted in the foundations of the Postal Telegraph building, on the corner of Broadway and Murray St., New York City. Apparently in this building independent caissons were sunk, but the methods adopted for closing the space between them differed from that set forth in the O'Rourke patent, and the judge held therefore that the latter was not anticipated.

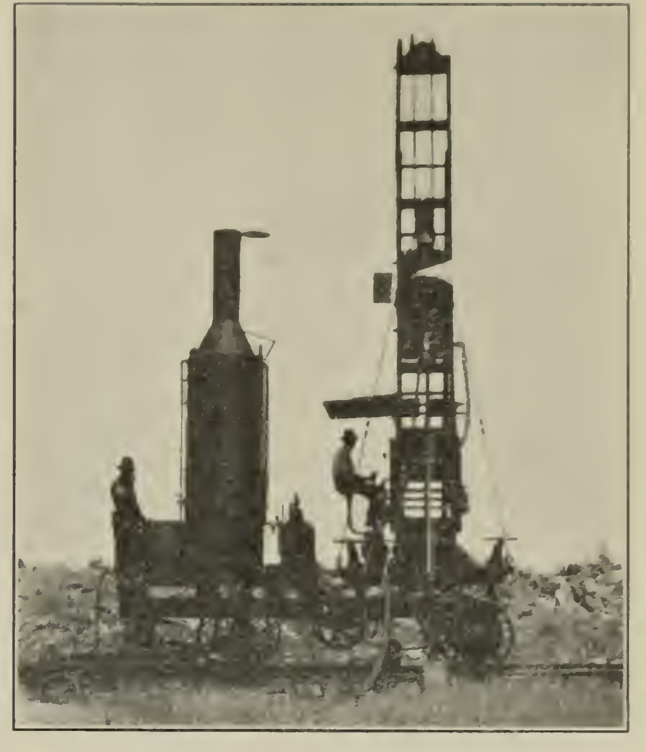
DRILL WAGONS IN QUARRY WORK

At the quarry of the Dewey Portland Cement Co., Dewey, Okla., the one thing to be accomplished is the getting out of the material in condition suitable for the crushers and at as low a cost as possible for the operation. The surface of the rock is practically level and the general scheme is to drill holes to a uniform depth and about 10 ft. apart, loading them with 3 in. 40 per cent. gelative and firing a large area at once, the object being to raise the rock and break it up, and not to throw it out into the quarry, the subsequent handling of the rock being done by a steam shovel.

During the present year the drilling has all been done by one drill wagon equipment. This comprised a standard Ingersoll-Rand H-64, 20 ft. feed, turntable drill equipped with a 35 hp. boiler. Ordinarily the machine is operated by one drill runner and one helper, and when necessary to move the track additional help is called up from the steam shovel and switching gang in the quarry. It is considered, however, that there should be three men constantly attached to the drill to run it most efficiently, as even though the boiler is gas fired, it requires considerable attention to keep the steam right, and the one helper can hardly find time to keep things going all right at each end of the wagon.

When demonstrated for acceptance this drill did from 140 ft. to 200 ft. of 3¼ in. hole per 10 hr. day, the holes being from 18 to 20 ft. deep. The drill was sold under a 150 ft. guarantee, which was easily made to the satisfaction of the quarry owners, and no attempt was made by the demonstrator to make or break any records, most of his time being spent in teaching the new operator how to get the best results. Another reason for not attempting any astonishing records in this case was in the fact that there was great objection to the water used in washing the cuttings out of the hole, as the rock mixed with this water becomes more or less muddy and does not go through the crusher as well, so that it was necessary to reduce the supply of water to a minimum and then the drill throttle could not be opened to take full advantage of the power available. Under other conditions the drill would not be under this handicap, and could make a still better showing.

At each setting of the wagon on the track one hole would be drilled on the side, with the drill in the position shown in the photo, Fig. 1, and then the turntable would be given half a turn for drilling a corresponding hole on the other side of the track; after moving the machine along 10 ft. on the track two more holes would be drilled in the same way, and so on.



DRILL WAGON IN QUARRY.

THE SAND BLAST FROM THE USER'S VEIW-POINT

BY H. D. GATES.*

The foundry sand-blast was developed for the cleaning of castings, and its many advantages for cleaning or surfacing in all branches of metal working, plating and finishing have been so fully demonstrated that it is today a fixture. Thoroughly sand-blasted castings can be machined more rapidly and at reduced expense. The value of the sand-blast in sheet and structural steel work has been thoroughly demonstrated, and the railroads generally demand the sand-blasting of steel cars before painting. A smooth surface results and the paint protects the metal better from corrosion. Metals to be plated, japanned, galvanized, sherardized, or treated with the various rust prevention processes, such as "Coslettizing," "Bower-Barff," "carbonium," etc., are thoroughly cleaned by the sand-blast preparatory to treatment. Bars, rods and plates to be electrically welded are freed from scale and rust in order to insure perfect contact.

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*Abstract of paper before Associated Foundry Foreman of New York.

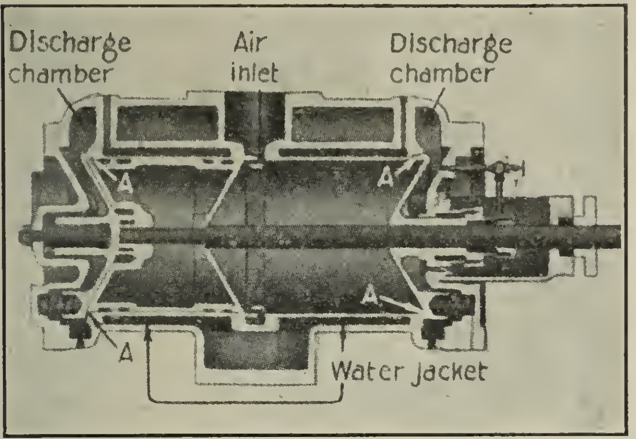
A variety of sand-blast apparatus is available for foundry-men and other users; for small work adapted in size and shape for cleaning in the sand-blast barrel there can be no question of the economy of this type of machine. Pieces too large for successful barreling may be cleaned with the least labor on the round and reciprocating type table machines, but if the pieces are of such shape or design as to demand constant turning to bring all surfaces under the action of the nozzle, one of the small enclosed cabinets of the self-contained continuous feed type, with stationary or portable nozzle, may be found more efficient. The combination pressure blast and cabinet machine also affords at small cost efficient equipment for a small volume of work of varied character. It is safe to say, however, that the varied character and limited output of the majority of foundries and other plants requiring sand blasting equipment is best served by machines that will clean everything and anything. For these the hose type machine is most efficient. It is simple, having few working parts, and the up-keep cost is reduced to a minimum.

Under pressure of 80 pounds per square inch a 3-16 inch nozzle will discharge 48 cubic feet of free air per minute and 500 pounds of sand per hour; a ¼ inch nozzle discharges 85 cubic feet of air per minute and approximately 900 pounds of sand per hour; a 5-16 inch nozzle, 133 cubic feet of air per minute and 1300 pounds of sand per hour; a ⅜ inch nozzle, 191 cubic feet of air per minute and 1700 pounds of sand per hour; a ½ inch nozzle, 340 cubic feet of air per minute and approximately 3000 pounds of sand per hour.

What is the most satisfactory working pressure is a question much discussed, but to which there is but one answer, and that is the pressure at which the work can be done the cheapest, all other factors being considered. If it is required to remove loose sand from castings a working pressure of 30 pounds or less will undoubtedly be satisfactory even on iron or steel, and should provide a surface suitable for painting. If, however, the castings are to be machined, every particle of the fused sand should be taken off in order to expose the clean metal to the action of the cutting tool. This condition on steel can be secured only with sand-blast pressure up to 90 pounds in order to be economical. Removing all the fused sand will not only reduce tool expense materially, but in actual practice has demonstrated that the output of machine tools will be increased at least 15 per cent.

In order to determine the most economical pressure for sand-blasting apparatus there must be taken into consideration, besides the elements of labor and abrasive, the initial pressure at which the air is being delivered from the compressor. The majority of pneumatic equipment in use today requires about 80 pounds pressure, and in some installations of sand-blast apparatus we find the air supply is being delivered to the receiver at this pressure. While it might be demonstrated that the castings could be most economically cleaned at a lower pressure if the air were initially compressed to that pressure, it is manifestly cheaper to use the air at the full or standard pressure of 80 pounds if other requirements in the plant demand that pressure. The fact must not be lost sight of that every cubic foot of air used for sand-blast purposes which is reduced to the lower pressure costs the same in horsepower expenditure that it would if it were used at the initial pressure of 80 pounds.

Tests made by Prof. William T. Magruder, reported in a paper read before the American Society of Mechanical Engineers, to determine the amount of metal removed by a sand-blast showed that the time required to remove one pound of iron with 20 pounds pressure was 3.55 hours; 30 pounds, 2.77 hours; 40 pounds, 2.13 hours; 50 pounds, 1.52 hours; 60 pounds, 1.07 hour; and 70 pounds, 0.82 hours. In one instance it was shown that 230 cubic feet of free air requiring 73 horsepower to compress, was discharged through a 9-16 inch nozzle at 40 pounds pressure, and 120 pieces weighing 200 pounds each were cleaned in a ten-hour day. With a pressure of 80 pounds passing through a ½ inch nozzle, flowing 140 cubic feet of free air per minute, 156 pieces were cleaned in ten hours. In the first instance the air was compressed to 80 pounds and passed through a reducing valve to the sand-blast machine. Had the air in the first instance been initially compressed to 40 pounds the power saving would have been over 12 per cent. of the higher pressure to say nothing of the greater output. The general proposition of the low pressure cleaning is volume of sand, which requires the large hose and nozzle, consuming air at low pressure and cost, while the high pressure provides a minimum of sand driven with high velocity through a small hose and nozzle with high pressure and cost of air. The horse-power cost is approximately the same for the same results by either operation with the air initially compressed to the operating pressure, and the determining factors will therefore be the volume of output with a minimum of labor cost.



AIR PUMP WITHOUT CLEARANCE.

AN AIR PUMP WITH NO CLEARANCE.

An air pump, invented by E. W. Christie, mechanical engineer of the Wheeler Condenser & Engineering Co., at Carteret, N. J., solves the question of clearance by using a central belt port (like the Unaflow engine's exhaust) for an inlet port and making the cylinder head the exhaust valve.

Referring to the accompanying section, when the piston is at the end of its stroke the central port is uncovered and the cylinder fills with air and vapor of the pressure existing in the condenser, together with some water. The first movement of the piston on the return stroke covers this port and the air and vapor are compressed and, with the water, discharged at *AA* when the head which forms a discharge valve is lifted from its seat against the tension of the seating springs. The movable heads are made to fit closely into the piston so that the clearance is eliminated.

The cylinder barrel is completely water-jacketed except at the air-inlet ports. The pump is of the "wet air" type, removing both air and condensate, but may be used for air only by furnishing a slight amount of sealing water. It is adapted to either the crank-and-flywheel construction or for connection to direct-acting steam cylinders, with which, regardless of the variable stroke, the air is completely discharged and a high vacuum is thereby maintained. The combined equipment—direct-acting air and condensate pump at one end, steam cylinder in the center and direct-acting circulating pump at the other end—usually good for 25 to 26 in. of vacuum—will, with the Christie pump, maintain a vacuum of 28 in. or more. In tests at the shop, guaranteed performances of 28 in. with 80-deg. water are easily surpassed. A higher vacuum result was as follows:

Barometer	30.2 in
Vacuum attained	29.4 in.
Pressure in condenser (abs.)	0.8 in.
Temperature sealing water	60.0 deg. F.
Pressure corresponding to 60 deg. F	0.522
Pressure in excess of that of vapor	0.278

The pressure in the condenser was less than 0.3 of an inch more than the vapor tension due to the temperature of the sealing water, showing that the pump maintains a vacuum nearly the theoretical maximum.—*Power.*

FALLING BODIES IN DEEP MINE SHAFTS

The Michigan College of Mines, Houghton, Mich., has made some tests of falling bodies in a deep vertical shaft of a copper mine at Calumet, Mich. Within a radius of a mile from Calumet are three of the deepest shafts in the world, one of them being 5,300 ft. deep. One of the experiments consisted in dropping a smooth metal ball 2 in. in diameter from the centre of the shaft and trying to catch it in a box of clay placed 4,200 ft. beneath. Another ball was dropped from the south-west corner of the shaft. The balls were dropped by burning threads by which they were suspended so that they started to fall without any lateral motion. The shaft is 9 ft. by 30 ft. in cross-section. The first of the balls was suspended 4 ft. from the side of the shaft and the second from a point 9 ft. from the opposite corner. Neither of the balls reached the box of clay; one of them was never found and the other, presumably the one started from the centre, was found by a workman lodged in the timbers on the east side of the shaft 800 ft from the surface.

Bodies dropped into the shaft invariably lodge somewhere in the east wall. This action takes place because the earth is rotating on its axis from west to east. At Calumet a particle at the surface is moving to the east at the rate of about 1,000 ft. per second; but a particle 5,000 ft. down the shaft, having the same angular velocity as the particle on the surface, is moving eastward at a rate of 4 in. less than 1,000 ft. per second. The ball suspended at the top of the shaft had a 1,000-ft.-per-second velocity; it was not only moving eastward at that rate when it started to fall, but continued moving eastward all the way down the shaft. Meanwhile, it dropped to the bottom at a rate which would have taken 17¼ seconds for the fall, if there had been no air resistance to encounter. During the 17½ seconds, the particle at the surface and the ball falling at the same rate would have travelled 17½ times 4 in., or nearly 6 ft. further eastward than the particle at the bottom of the shaft. The ball started from the centre of the shaft, therefore, struck the east wall long before it reached the bottom. As a matter of fact, the resistance of the air at the high speed the ball acquired soon after starting, was sufficient to prevent any further acceleration, and consequently the ball was much longer than 17½ seconds in falling. In fact, only 800 ft. of fall was required for the ball to make the 4 ft. from the centre of the shaft to the east wall and the other ball must have lodged at some point not much further down.

If the walls of the shaft were smooth and free from obstruction, no doubt a falling body would rebound from side to side of the shaft and finally reach bottom, but the many timbers in the lining of the shaft and the levels all the way down furnish places where a body is sure to lodge, and so if a load of ore were to be spilled into the shaft near the top most of it would later be found clinging to the shaft or stranded on the levels east of the shaft.

Buoys of reinforced concrete built for Kingston, Jamaica, weigh each about 5 tons, carry about one ton of ballast, and are said to cost a little less than half as much as steel buoys of the same size.

MACHINE COAL-MINING

According to returns made by the United States Bureau of Mines, the use of coal-cutting machinery is rapidly advancing. In the year 1900, about 20 per cent of the output was won in this way, whereas in 1913 the proportion had risen to 46 per cent. In Great Britain the advance had also been notable, but is still far behind that of the United States, for in 1913 only 9 per cent. of the output was won by machines. The following tables give the number of machines in use, the amount of coal won by machines, and the output per machine during the last few years.

UNITED KINGDOM.

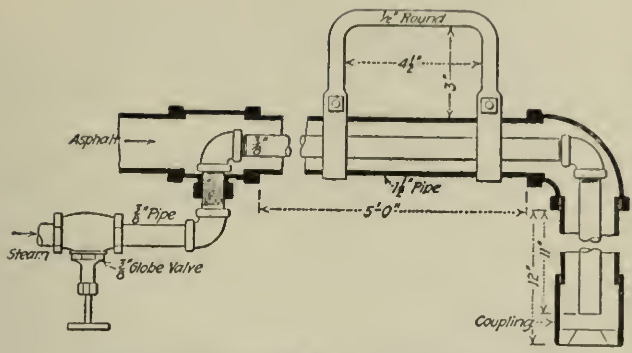
Years.	Machines in use.	Coal won.	Production per Machine.
	No.	Tons.	Tons.
1900	311	3,312,000	10,650
1902	478	4,161,200	8,706
1905	946	8,102,200	8,564
1906	1,136	10,202,500	8,981
1910	1,959	15,878,800	8,105
1911	2,146	18,667,300	8,698
1912	2,444	20,274,100	8,295
1913	2,894	24,609,300	8,503

UNITED STATES.

Year.	Machines in use.	Coal won.	Production per Machine.
	No.	Tons.	Tons.
1900	3,907	47,129,000	12,062
1902	5,418	62,153,300	11,471
1905	9,184	92,318,200	10,052
1906	10,212	106,113,800	10,390
1910	13,254	155,368,100	11,722
1911	13,829	159,070,000	11,503
1912	15,298	187,981,100	12,280
1913	16.381	216,496,900	13,216

During the same time, the total United States production advanced from 240,800,000 tons in 1900, to 509,000,000 tons in 1913, and the British production from 225,000,000 tons to 287,000,000 tons. Of the various types of machine, there were in 1913 in Great Britain, 1246 disc, 542 bar, 250 chain, 839 percussive, and 17 rotary heading machines. In the United States the classification was: 6327 pick, 6936 chain-breast, 791 longwall, 2210 shortwall, and 117 radialax or post machines.

An average day's work for a fireman on a large locomotive is to handle 25 tons of coal at the rate of about five 15-lb. shovelfuls per minute of a 10-hr. day



SPRAYING HEAVY ASPHALT

The accompanying illustration shows the details of a spraying nozzle used on all the asphalt distributing wagons of the Illinois State Highway Department. Steam and compressed air are supplied by a steam road roller or traction engine, used to draw the asphalt tank wagon. The nozzle is attached to the tank wagon by a flexible hose connection and the hot liquid asphalt is forced out under air pressure in the usual way. This type of nozzle is suitable for all grades of asphalts or tars. It has been found to be very satisfactory in surface-oiling roads, as the material can be applied in a very fine mist in any quantity desired from ⅛ gal. to 2 gal. per sq. yd. The steam connection near the base of the spray superheats the bituminous material and also breaks it up into a very fine spray as it comes from the nozzle under the air pressure. There are other advantages in this type of nozzle, inasmuch as the high pressure that can be secured will remove surplus dust from the surface of the road and also force the bituminous material into all interstices of the road surface.—(P. C. McArdle, Acting Chief Engineer, Illinois State Highway Department.—*Eng. News.*)

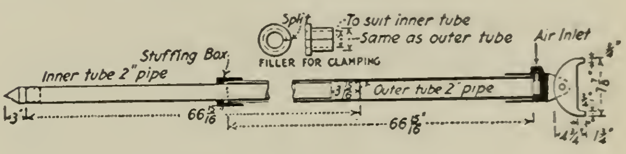
PNEUMATIC DRILL COLUMN

BY SVEN V. BERGH.

An important factor to be considered in getting the highest efficiency out of the modern hammer-drill is the simplification of the drill mounting when such mounting is required. The labor cost, compared with the other costs of operation, is in most cases predominant, and it must be borne in mind that, roughly estimated, only 40 to 50 per cent. of the total shift can be used for actual drilling, the rest being absorbed in setting up and other manipulation of the machine.

When a column or bar has to be used the drill may be either attached to it directly or it may be carried on an arm; the column itself may be either the single-screw or the double-screw type. In any case, its height is adjustable to only a limited extent. Hence, to make a set-up in the best position for the round of holes to be drilled, the workman has to use a good deal of skill and do considerable planning; in most cases a lot of time is wasted in mucking, arranging blocking, picking down back or picking up bottom, in order to get good bearing surfaces for the column.

To facilitate these operations, a pneumatic drill-column was devised and has been used with good results for several years at the iron mines of Malmberget, Sweden. It resembles in general the telescopic air-feed of the stoper type of drill. A longitudinal section is shown herewith. The height of this particular column can be varied between 6.23 and 11.48 ft. When the column is fully run out, the compressed air is shut off by means of an automatic cutoff valve. There is no need of the usual arm in order to provide a sufficiently wide range of positions for the machine. The column, drill and all are easily removed from one position to another as required, and the absence of an arm makes this all the easier. The drill-clamp is adjustable with one single screw-bolt, and is made with a hinge so that the machine can be swung over to one side, when the drill steel has to be changed. The clamp is attached to the outer tube. This has a toothed foot-piece which bears on the bottom and resists rotation. The inner tube ends in a point which bears against the back. It is, of course, not subject to any torsion.



The column was found sufficiently stable when the regular drilling pressure was used, but is adapted only to light hammer drills of the stoper type with telescopic air feed and for drilling in soft to medium-hard rock.

It should be noted that when air is turned off, the machine first stops drilling and the air in the column maintains static pressure for some time. It can, however, be exhausted rapidly if desired.—*Eng. and Min. Journal.*

PAINTINGS DESTROYED BY AIR AND GASES

One of the reasons that the ancient paintings have lasted so long as compared with some of the modern is the fact that the condition of the atmosphere in a modern city is so totally different now from what it was prior to the invention of some of our modern conveniences. For instance, in the city of New York the air contains a perceptible amount of sulfuric acid, due to the burning of hard coal. In the city of Pittsburgh and in the city of London the air contains other acids, and coal dust in addition. The influences of coal gas and of the products obtained from burning illuminating gas are sufficient to have a serious effect on paintings. Then, again, light and darkness are important factors in the preservation or destruction of pictures. Light bleaches and darkness blackens, and a painting which remains in a dark corner for six months turns yellow wherever oil, or an oil varnish, was used on it.

In restoring paintings one of the simplest methods, and one of the most efficient is, after wiping them free from dust and dirt, to place them in the bright sunlight for two or three days, and the sunlight will bring back the colors, excepting such modern lake colors as are faded by the sun, in all their pristine glories.

BOILED CABBAGE.

Another destructive agent to paintings in homes is the gases derived from the cooking of vegetables. Certain veegtables contain a large amount of sulphur, which is easily liberated, particularly in the presence of vinegar, and this sulphur affects the colors, particularly those containing white lead, lead pigments, and others. To a very large degree varnishing preserves paintings from the influence of gases, but, of course, the varnish used must not be made with a drier which contains any chemical affected itself by gases.

Then there is the interaction of one color upon another. Ultramarine blue, which is perfectly permanent by itself, when mixed with flake white and subjected to the influence of an acid gas changesin color from a sky blue to a dirty brown.—*Maximilian Toch, before Franklin Institute.*

The Tonopah and Tidewater Railroad has completed its twenty mile branch line, called the Death Valley Railroad, across the Funeral mountains, from Death Valley junction to the edge of the valley.

THE ENGINEER'S THE BLOKE

BY ROBERT T. GEBLER.

You can rave about yer bloomin' Tommy Atkins on parade
And yer lady-like lieutenants on the Mall.
You can talk about your gunboats, yer rifles and yer camps
And yer heroes in the rain of leaden ball.
But the bloke I doffs me hat to
Didn't fight the sly mulatto
But he was in the battle just the same.
He's the bloke that planned yer bridges,
Built yer roads across the ridges,
To let Tommy Atkins march into the game.

With 'is transit or 'is level he would work to beat the devil—
The devil of a Kaffir, sir, I mean—
But the blokes as write the stories never pass 'im any glory
And they never throws 'im on the movie screen.
Out there 'e is a plannin'
And a river 'es a spannin'
As 'e gets the place in order fer the fair;
But the 'eathen start a shoutin':
They've fergotten all about 'im
And the history won't say that he was there!

Yer millionaires cut capers, get their pictures in the papers
And the public then begins a bloomin' 'owl
'Bout the aqueducks 'en highways, the railroads and the byways
An' big jobs like the Panama Canal.
But as I've often read it—
The bloke who gets the credit
Is not the dusty khaki'd engineer;
But the guys wot 'ave the shillin's
Get in first on all the killin's,
Of the lad who turned the trick we never 'ear.

So I think when I am ridin' down to Dover, or a glidin'
In a taxi 'cross the bridge in Lunnon town.
Of the lads who built the town, sir, and the sewers under groun', sir.
The sea wall and Suez and did 'em brown.
But they never sings 'is praise, sir
In the papers nowadays, sir;
'E never gets the credit that's 'is due.
But the fellers with the money
Wouldn't get the praise and honey
If the engineers wern't there to pull 'em through.

—*Engineering News.*

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MAGAZINE
EVERYTHING PNEUMATIC

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THE SLOW ADVANCE OF TUNNEL RECORDS

The planning of new railroad tunnels goes on continually, both for the straightening, regrading and general improvement of existing trunk lines and in the building of lines entirely new. Even in Europe, whose transportation lines we are apt to think of as more or less completely finished, they being more carefully planned to begin with, we still record at frequent intervals the planning, the beginning of construction, the holing-through or the completing and opening to traffic of new tunnels one after another, and in America the same story is told more frequently, continuing without end.

In our present issue we give a brief account of the making of a new American speed record in tunnel driving. Although such records are not fairly comparable, since so many conditions vary, both as to the actual work to be done, the nature of the rock, etc., and also as to the men, means and methods employed, still, after all allowances are made, it is not altogether satisfying to note a difference of 20 per cent. or more between the European and the American results.

The American method of driving by a top heading, at least for long tunnels, and when, as is generally the case, speed is the most imperative demand, seems to have been more or less discredited, and other methods are being adopted. In a 2½ mile tunnel of recent date, through the Cascade Mountains near Seattle, the European bottom heading plan was followed, while at the Rogers Pass 5 mile tunnel we have the novelty of a pioneer parallel independent tunnel, which not only pays for itself but saves more than that in the actual cost of the main tunnel.

Both of these methods give the one great advantage of allowing the work of cutting the bulk of the rock in the main tunnel to be carried on at several faces at once, thus dividing up this heavier work, and enabling it always to more than keep pace with the advance of the first heading, the speed record for the entire job depending upon the latter as the pacemaker.

We may say that undoubtedly the general tunnel driving speed has increased, and we may be confident that it will continue to do so, but our progress in this particular is not what should have been expected from the great and rapid advances in working speeds in lines with which the tunnel work is closely associated.

For all outdoor work in rock breaking and rock handling, with the powerful explosives now employed, the heavy steam- or air-actuated shovels, drag lines, overhead conveyors, high capacity dump cars, unloading plows and similar devices, speeds have doubled and doubled again, but the drill in the heading shows no such great jumps in achievement. The substitution of the light, quick handled one man drill has done much, but much more is required to keep up this end of the work, and here we must be on the alert to seize whatever chances may develope.

There are tunnels innumerable, some definitely planned, some only thought of, and some out of sight beyond that, which only await quicker and cheaper methods of tunnel construction. Tunnels of great length, the last objection to which has been removed by the advent of electric traction, offer the solution to many of the urgent problems of the many mountain divisions when the costs of construction and the time required cease to be prohibitive.

THE BUREAU OF MINES ON MINE EXPLOSIONS

In his annual report to the Secretary of the Interior, Director Joseph A. Holmes, of the United States Bureau of Mines, states that excellent progress has been made during the past fiscal year in the investigations of the explosibility of coal dust, at the experimental mine near Bruceton, Pa.

Probably the most important feature of the year's work was the development of four types of explosion-stopping devices in which rock dust is used, as follows: Box barriers, concentrated barriers, ventilating-door barriers, and ventilation-stopping barriers. The barriers were tested in strong and in weak explosions and were effective in preventing propagation of flame beyond them. Demonstrations before mining men led to inquiries from a number of companies, with a view to the erection of the devices in mines.

The results of the tests at the experimental mine have shown the value of watering and of steam humidifying systems, and the peculiar merits of rock dust, both when distributed throughout the mine and when used as barriers for limiting explosions.

Four great explosions occurred during the year, as follows: One in the Stag Canyon mine, at Dawson, N. Mex., October 22, 1913, resulting in the death of 263 men; one at Acton, Ala., November 18, 1913, in which 24 men were killed; one at the Vulcan mine, New Castle, Colo., December 16, 1913, in which 37 men were killed; and one at Eccles, W. Va., April 28, 1914, in which 181 lives were lost. The general ventilation in most of the mines involved in explosions was good, but the defect in certain mines was in permitting the local accumulation of gas through not bratticing up to the face of gaseous entries or working places. One of the great disasters was probably caused by the use of dynamite for blasting, and by disobedience in firing a shot or shots when miners were in the mine, in spite of the fact that an outside shot-firing system had been installed.

Other lesser disasters occurred during the year. Many shot firers lost their lives in the Pittsburg, Kans., district, and in Oklahoma, Indiana and Iowa. Although the system of employing shot firers to fire the shots when all others are out of the mine lessens the number of deaths, yet in many districts the methods of shot firing employed are still so extremely hazardous that only the most reckless men are willing to act as shot firers.

Director Holmes strongly urges the purchase by the Government of the grounds on which the experimental mine is situated. He declares that the Bureau of Mines should own these grounds, now merely leased, in order to safeguard the large expenditure already made in developing the mine thereon and equipping it with expensive appliances.

Looking to the future, the Director observes that, despite the progress made in ascertaining the nature of mine explosions and in devising methods of prevention, they still continue to occur, and it is to be feared that complete prevention will be difficult, owing to the inherent difficulty of eliminating errors of observation, judgment, or understanding from among miners or mine officials. Thus, one of the shocking disasters of the past year was brought about because of one man's willingness to risk the sacrifice of not only his own life but the lives of many others in order to gain a few tons of coal. It is difficult to meet such a case, and yet with the progress that is being made in the methods of preventing or limiting explosions, it is certain that hereafter in a well-protected mine properly cared for there will be much less danger of a widespread explosion.

THE IMPORTANCE OF CORRECT METHODS IN PRIMING DYNAMITE

A great many blasters think that the priming of a dynamite cartridge is of very little importance—if the dynamite goes off, that is all there is to it. It is not widely known that the success or failure of a good many blasts depends on the position of the detonator—blasting cap or electric blasting cap—in the dynamite. Not only the amount of work done depends in a large measure on the priming but also the safety of the loading operation is affected in many instances by the position that this detonator occupies. Many accidents have occurred and many men have been killed in loading holes with a primer made so that the detonator became jammed or wedged in the hole and exploded when the blaster endeavored to force it down.

The points to be borne in mind in making a primer are the following:

The detonator, and by detonator is meant either a blasting cap or electric blasting cap, must be in such a position that it cannot become jammed in the bore hole.

The detonator must be in such a position that it will not be struck by the tamping stick.

The detonator must be fastened to the cartridge in such a way that when the wires or fuse are held in one hand by the blaster, and the cartridge seated with a tamping stick held in the other hand, the detonator will not pull out.

The detonator must be entirely embedded in the dynamite.

The loaded end of the detonator, or the closed end, or the "business end' should point toward the bulk of the charge, not away from it. The detonator should not be secured by metal wires, etc.

With an electric blasting cap, the wires should not be fastened on with a half hitch, for although this practice is very common, there is always a chance of a short circuit occurring, especially when high voltage power currents are used for firing.

With blasting cap and .fuse, the fuse must not come in contact with the dynamite except for about a half inch next to the cap. "Lacing" fuse through dynamite causes more burned charges than anything else.

The maximum detonating effect of a blasting cap or electric blasting cap is out from the closed end. If you place a dozen cartridges of dynamite, end to end in a straight line on the ground and fire a blasting cap in the end cartridge, with the blasting cap pointing towards all the other cartridges, the entire line will go off, but if you put this primer in the middle of such a line, some of the cartridges back of the detonator, that is, those away from which the detonator is pointed, will often fail to explode. If you put the primer cartridge at the end of such a line, pointing it away from the line, that is, pointing it towards the open air, generally the primer only will explode. This does not always happen in a bore hole, because there the explosive wave is strongly confined, but this shows a tendency of the dynamite, which is in the opposite direction from the closed or "business end" of the detonator, to misfire. Several years ago this was demonstrated to a sceptical individual in a quarry shot where there were 27 holes, each hole containing from 19 to 21 cartridges of dynamite; 13 of the holes having the detonator in the next to the last cartridge and pointing downwards, that is, towards the bulk of the charge; the rest of the holes having the detonator in the same cartridge, that is, the next to the last, but reversed, pointing upwards. These holes were all thoroughly tamped with sand and fired at the same time. While all the dynamite in both sides exploded, where the detonator pointed downwards the rock was broken and cleared from the ledge below the bottom of the holes; where the detonator was pointed upwards, about one-third of the distance from the bottom of the holes upwards, the rock was broken up but left in place. This showed that when the detonator pointed downwards, the full power of the dynamite was realized: where the detonator pointed away from the bulk of the charge, the full power was not realized but a great deal was wasted.

When a cartridge of 40 per cent. straight dynamite is suspended vertically in the air, and a blasting cap supported at right angles to it, and pointing directly at it is fired, the dynamite will explode at a distance of 24 inches from the blasting cap, but if a cartridge and blasting cap are hung parallel with each other, that is, the blasting cap pointing either straight up or straight down and parallel to the dynamite cartridge, so that it does not shoot directly at the cartridge, the dynamite will not explode until it is brought to a distance of 15 inches or less. When the blasting cap is horizontal and the cartridge of dynamite hung vertically and the cap supported at the level of the middle of the dynamite cartridge but pointed so that it does not point directly at the dynamite but a little to one side, this distance where an explosion occurs is lessened still more. When the cap is pointed directly away from the dynamite cartridge, it will not explode the dynamite cartridge every time even when within four inches of it.

The ideal primer with an electric blasting cap would be one where the detonator lies directly in the axis of the cartridge near the middle, and the wires secured to the cartridge, in such a way that they could not possibly pull out, by some strong non-conducting material like string. By using a curved puncher it is possible to get an electric blasting cap almost in this ideal position, where it may be held in place securely by taking a half hitch with a piece of string around the wires, is then carried once or twice around the dynamite cartridge and tied tightly with a square knot.

Another way of priming with an electric blasting cap without using string is to punch a hole through the cartridge about two inches from the end and lace the electric blasting cap through this and insert it in the side of the cartridge.

With short wires, four feet or less, the ends may be passed through this hole after the cap is inserted in the cartridge, but with two long wires is apt to either make the hole so large that it does not make a secure fastening, or it may even cut the cartridge in two.

With blasting cap and fuse, inserting the blasting cap in the side of the cartridge about one-third from the top and tying it tightly with one or more pieces of string, keeps the cap away from the tamping stick, and if carefully done with a curved puncher, places the cap almost in the axis of the cartridge.

The orthodox method of opening up the paper at the top of the cartridge, punching a hole in the dynamite, inserting the cap and fuse into that, and then tying the paper down around the fuse, gets the blasting cap in a good position but is a difficult operation to perform on account of the tendency of the string to slip off the paper and the difficulty of getting the string tight enough to prevent the fuse from pulling out. It also is liable to kink the fuse abruptly if the primer is seated firmly with the tamping stick.

Dynamite when strongly confined in a bore hole burns very raipdly when it is ignited and on this account the lacing of the fuse through the dynamite cartridge is a practice which is strongly condemned by all explosive manufacturers. It seems strange that very much of the dynamite would burn before the cap would explode but the fact is, dynamite burns very much more rapidly when confined than when in the open, and it has been known to burn up entirely in a bore hole which contained a perfectly good cap without any of the dynamite exploding, the cap of course exploding and doing no work. Burning dynamite makes a large quantity of exceedingly poisonous fumes, and a number of fatal accidents have occurred from dynamite burning up in the bore holes in mines and tunnels, due either to lacing the fuse through the cartridges, or from other causes, such as matches, sparks or burning oil dropping into the charged bore holes. These fumes from burning dynamite are so frightfully poisonous that no chance whatever should be taken of a charge catching fire, especially when it so so easy to prevent it by taking the proper care in preparing the primer.

In priming holes where it is necessary to have two primers, one should be near the top, pointing downwards and one in about the middle also pointing downwards. Where three primers are used, place one at the top, one about one-third way down and one about two-thirds way down; that is, equally distant from each other and from the bottom of the hole.

The bane of blasters in mines and tunnels is the smoke and fumes from the explosive, and while no explosive has yet been invented which does not give off more or less irritating fumes, the quantity of fumes given off can be materially decreased by insuring complete detonation of the charge by using the strongest obtainable blasting cap or electric blasting cap, by inserting the primer in either the last or next to the last cartridge in the hole, and placing the detonator so that the "business end" points towards the bottom of the hole, and by using an adequate amount of good tamping material on top of the explosive charge. The reason why it is advisable to place one cartridge on top of the primer is that it serves to cushion the primer from the tamping stick when used for packing the tamping. The stronger the confinement and the larger the detonator, the more perfect the explosion will be, and the less amount of noxious fumes will be given off.—*DuPont Magazine.*

JACKHAMER SUPERSEDES HAND AUGER DRILL

Charles H. Claypool, superintendent of the Cavour Mining Company, Virginia, Minn., reports some interesting results from the use of the Jackhamer drill on the Mesabi Range.

Previous to the introduction of the air auger, the system employed at the Cavour mine was that generally used on the Mesabi. The miners drilled and blasted their own ground, put in their own timber with the help of a timber man, mucked up the ore and trammed it to the pockets. Hand augers were used in drilling, and two miners could drill a round of five 6-ft. holes in about two hours, the Cavour ground being somewhat harder than the usual Mesabi ground. The average speed was about 1 ft. in 8 min. Blasting was done at the noon hour and at the end of the shifts, and occasionally during the shift. In places where the air circulation was not good, considerable time was lost in waiting for the air to clear up. When working two shifts, five gangs of miners each, the production ran about 3.75 tons per man for every man employed, this low figure being due to the small number of producers compared to the number of nonproducers employed.

The introduction of the air auger permitted the system to be changed so that muckers were employed instead of miners. Under the new scheme, all the drilling and blasting are done by two men and the timber is all handled and put in by regular timber men. The muckers simply shovel ore and tram it to the pockets. All drilling, blasting, timbering, track work and underground repairs of all kinds are done on the night shift, so that nothing interfers with the tramming and hoisting, which is done only on the day shift.

The advantage in this system of working is that there are special men for each kind of work and each man becomes an expert in his particular duty. As a result, it has been found at the Cavour mine that the powder cost has been reduced over 50 per cent., because the drill men become proficient in placing holes and using powder. The cost of timbering has likewise been greatly decreased. Under the new system, the production per man is about 5.25, compared with 3.75 tons per man with the old system, the total production remaining the same. The drilling speed has increased from 1 ft. in 8 min. to 1 ft. in 1 min. The muckers tram an average of 26 tons per shift per mucker.

The item of labor in drilling has been greatly reduced by the air machines, and while the increase in production per man is probably due largely to the new system of operation, the latter has been made possible only by the use of the air auger.

A PORTABLE GAS EXPLOSION

An accident with fatal results which occurred recently at Hagerstown, Md., and which was reported as an acetylene tank explosion, calls for a somewhat different explanation. The occurrence was in a junk yard where a gas torch was being used for cutting up old material. There was no acetylene in use at the yard when the explosion took place. They were using blau gas and this, being transported in a liquified state, called first of all for a supplementary receptacle for the expansion of the gas before it could be used. A blau-gas cylinder had been emptied and was removed. Then the men of the yard by mistake, attempted to attach an oxygen cylinder. As the fittings didn't match, they went to the extreme of wiring the cylinder onto the connection. The open valve in the oxygen tank allowed the oxygen to mix with the blau gas in the expansion chamber. They ignited the torch, which in a moment blew itself out. They again ignited the torch, and this time a flash-back occurred into the expansion chamber and the oxygen and blau-gas mixture exploded with serious results. These statements clearly show that the human equation entered into this accident to the extent of 100% and that no cylinder of compressed gas of any kind exploded.

NOTES

The Münster Grenchenberg Tunnel near Bern, Switzerland, was holed through on October 27, 1914. The tunnel is 5⅜ miles, or slightly longer than the Hauenstein base tunnel, which was holed through July 10. The new tunnel is located north of the Lötschberg tunnel on the main route to Italy via. the Simplon tunnel. Its construction has taken 3½ years and its cost is about $5,000,000.

A single blast on the shores of San Francisco bay recently broke 166,250 tons of rock in a suitable condition for removal by steam shovels. There were eight holes and each pound of powder broke 9.5 tons of rock.

The longest railway tunnel in India is that piercing the Khojak Range between Quetta and Chaman, near the northwestern frontier, which has a length of 12,870 ft. The second longest tunnel, 3,900 ft. is now being driven on a double-track cutoff between Thana and Diva. This pierces the Parsik Hill and reduces the distance 11 miles as compared with the present line, which makes a detour around the hill

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From experience with tread mills in British prisons, we know accurately the mechanical equivalent of hard labor. It is a climb of 8,640 ft. in 24 hr. If the average weight of a man is 150 lb. he can do approximately 1,200,000 ft.-lb. of work each 24 hr. A horsepower for 24 hr. is approximately 48,000,000 ft.-lb. It would require 40 men to develop a continuous horsepower, and their wages would would be $80 per day, or $28,800 per year.

The use of a fluid composed essentially of glue and calcium chloride in solution, for laying coal dust, has been tested on a commercial scale at a Newcastle colliery with, it is affirmed, effective results. The liquid is placed in a specially designed 100-gallon tank, mounted on wheels, and is applied in the form of a spray, at a cost (which does not appear to be prohibitive), of about fifty cents a yard per annum. One application suffices for three months. Besides, successfully accomplishing the primary purpose of laying dust, the liquid acts also as a preservative of timber.

The space available in the lower portions of five reinforced-concrete chimneys completed recently for the Havana Railway, Light & Power Company, Havana, Cuba, has been utilized for storage rooms. As all chimneys are located inside the power house to economize on space two storage rooms were provided in each chimney. At an elevation 18 ft. above the top of the foundation a floor was placed and the chimney was provided with a doorway. Another floor was built giving 36 ft. above the top of the foundation another storage room.

After air enters a mine, the breathing of men and animals, burning of lamps, decay of mine timbers, and firing of shots take oxygen from the air and add carbon dioxide to it, but in well ventilated mines the air depletion from these causes is small. Much more important changes are those caused by oxygen being taken from the air by the coal; and by gases from the coal, the roof, and the floor being added to the air.

The use of moving pictures in the publicity field of the machine industry is not new, but examples of its extension are always of interest, and one firm in Hull, England, making oil-mill and other machinery for export, has a "private picture palace" for showing its machinery in operation under various circumstances. An important variation on this scheme is to send the films abroad, with or without a salesman, for the benefit of customers who might never have an opportunity to see the actual operation of the machinery in other countries.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 1.

1,118,987. TRAIN-STOPPING APPARATUS. FREDERICK WILLOCK, Scranton, Pa.

1,118,994. AIR-BRAKE. EDWARD W. WOOLLEY, Jersey City, N. J.

1,119,007. METHOD OF AND APPARATUS FOR DRAWING GLASS. ROBERT L. FRINK, Cleveland, Ohio.

1,119,018. CUSHIONING DEVICE FOR VEHICLES. THEODORE A. KLENKE and SIGWOOD OLSEN, New York, N. Y.

1,119,020. PNEUMATIC SUSPENSION DEVICE FOR SHAFT-DRIVEN MOTOR-VEHICLES. THEODORE A. KLENKE, New York, N. Y.

1,119,047. ARTIFICIAL ABDOMEN FOR COMEDIANS AND OTHERS. JOHN WOODARD SIMMONS, Ozark, Ala.

1. A means for the purpose described, comprising a bag of semi-ovate form when inflated, with one face concave, a container for compressed fluid, a connection for coupling the container to the bag for its inflation, and means for the deflation of the bag separate from the means for its inflation, said inflating and deflating means being located to permit their manipulation without exposure to view.

1,119,114. CARPET-CLEANING MACHINE. LINCOLN L. PORTER, Oskaloosa, Iowa.

1,119,198. PNEUMATIC ROCK-DRILL. Clark J. Smith, Ottumwa, Iowa.

1,119,214. MILKING-MACHINE. Charles M. Anderson, Waterloo, Iowa.

1,119,224. PNEUMATIC JACK. Johan Henry Behrens, Camden, N. J.

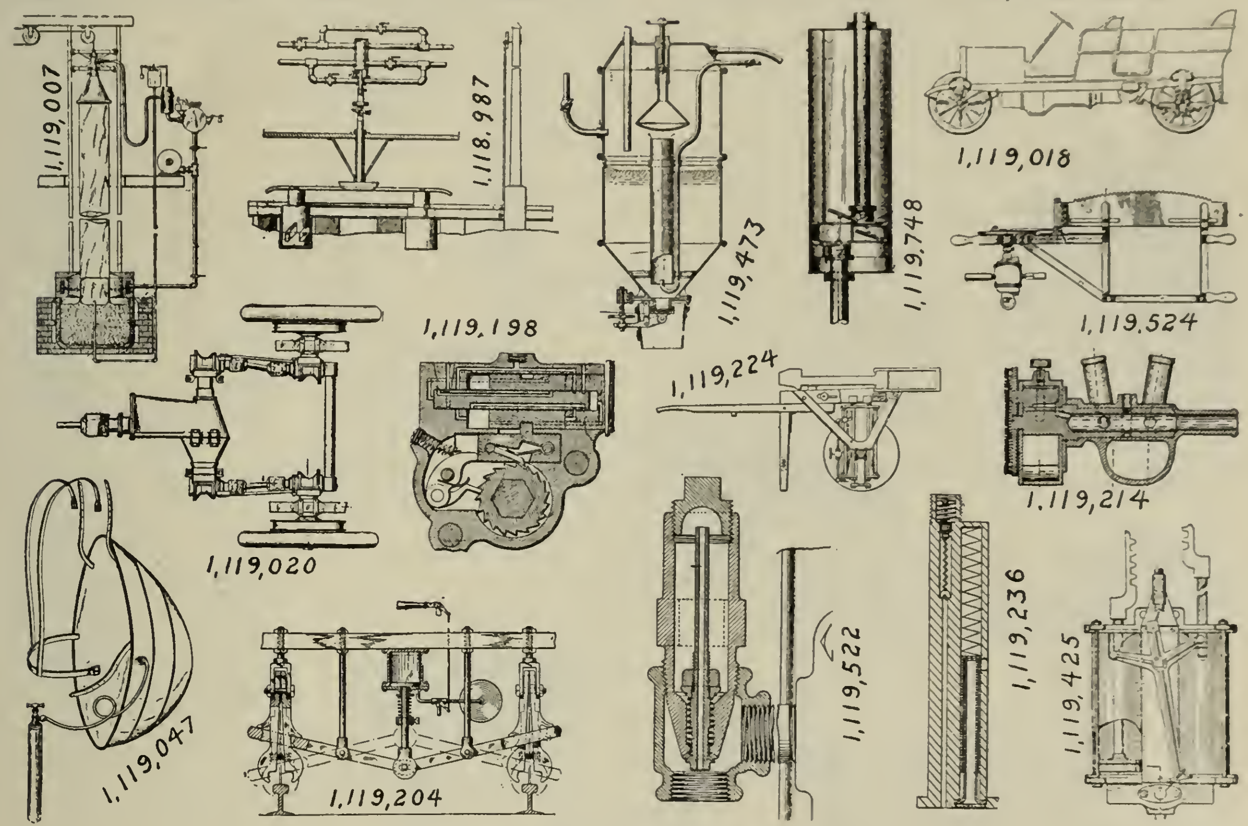
1,119,236. AIR-PRESSURE INDICATOR FOR PNEUMATIC TIRES. Carl O. Brenner, Descanso, Cal.

1,119,242. RAILWAY-BRAKE MECHANISM. Edward Carrau, Cathlamet, Wash.

1,119,425. FLUID-PRESSURE MOTOR. Edmond Guerin, Maisonneuve, Quebec, Canada.

1,119,473. PROCESS FOR TREATING ORES. William A. Thacher, Lake City, Colo.

1. The process of treating sulfid ores which consists in causing a stream of compressed air to pass through a charge of ore and acid in a closed vessel, and causing a spray of the charge to be spread across the surface of the charge in the path of the acid fumes and gases rising from the charge.



Pneumatic Patents December 1.

1,119,520. PROCESS FOR PASTURIZING LIQUIDS. Carl Krug, Frankfort-on-the-Main, Germany.

1. A process of pasteurizing liquids in bottles in a closed chamber, consisting in heating the chamber by supplying steam into the same, in shutting off the supply of steam, in supplying compressed air through and into the top of the chamber while the liquid in the bottles is being heated by the steam in the chamber, and in then opening an outlet of the chamber, whereby the compressed air is preheated while the chamber is being heated by the steam, subsequently ejecting the hot mixture of steam and air out of the chamber and gradually cooling the bottles.

1,119,522. OILER. Robert George McDowell, Walkerville, Mont.

1. In an oiler for pressure fluid operated tools having a fluid supply pipe, a closed oil reservoir having an oil supply passage leading to said fluid supply pipe, a hollow valve for said passage having a hollow valve stem affording communication between said fluid supply pipe and said oil reservoir and a spring for resiliently closing said valve, the said spring being of slight tension to permit the opening of said valve from the vibration of said tool.

1,119,524. PNEUMATIC PORTABLE RECIPROCATING SAWING-MACHINE. George E. Morris and Oscar F. Oliver, Jersey City, N. J.

1,119,713. CENTRIFUGAL AIR-COMPRESSOR. Sanford A. Moss, Lynn, Mass.

1,119,748. PUMP FOR VACUUM-CLEANERS. Alvin O. Carman, Tekonsha, Mich.

DECEMBER 8.

1,119,834. AIR-PUMP. Albert F. Krause, Buffalo, N. Y.

1,119,881. AUTOMATIC SAFETY-STOP FOR TRAINS. John V. Rund, Pesotum, Ill.

1,119,889. APPARATUS FOR COMPRESSING AIR. Stephen G. Skinner, Wilmette, Ill.

1. In an apparatus for compressing air which is adapted to be operated by the alternate suction and compression created within an internal combustion engine cylinder, the combination with a cylinder adapted to be connected with the engine cylinder, a piston within said cylinder, a movable compression chamber carried by said piston, a stationary piston for said movable compression chamber, and a valved passage whereby air admitted to said cylinder to operate the movable piston therein is passed to said compression chamber behind the piston therein and thence around said piston upon the next downward movement of said compression chamber.

1,119,899. TRIPLE-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,119,907. PIANO-PLAYER MECHANISM. William T. Waite, Laporte, Ind.

1,119,929. PROCESS FOR SECURING THE PRECIPITATION OF THE RARE-METAL OXIDS. Royal S. Davis, Newmire, Colo.

1. A method of securing the precipitation of the oxids of the rare metals, from solutions containing the acids, which consists in applying

super-atmospheric pressure to the acidulated and heated solutions.

1,119,960. PROCESS FOR MAKING INK. Robert Hochstetter, Cincinnati, Ohio.

2. The process of manufacturing ink, which consists in mixing a pulp color with a varnish in a suitable closed vessel, at the same time subjecting the mixture to the action of an air exhausting device adapted to reduce the pressure in said vessel, and applying heat to said vessel adapted to vaporize the water in the mixture at the reduced pressure.

1,119,972. ENGINE, AIR-PUMP, Etc. Fritz W. Machlet, Elizabeth, N. J.

1,120,011. PNEUMATIC ANTIVIBRATION DEVICE FOR AUTOMOBILES. George William Bell, Liverpool, England.

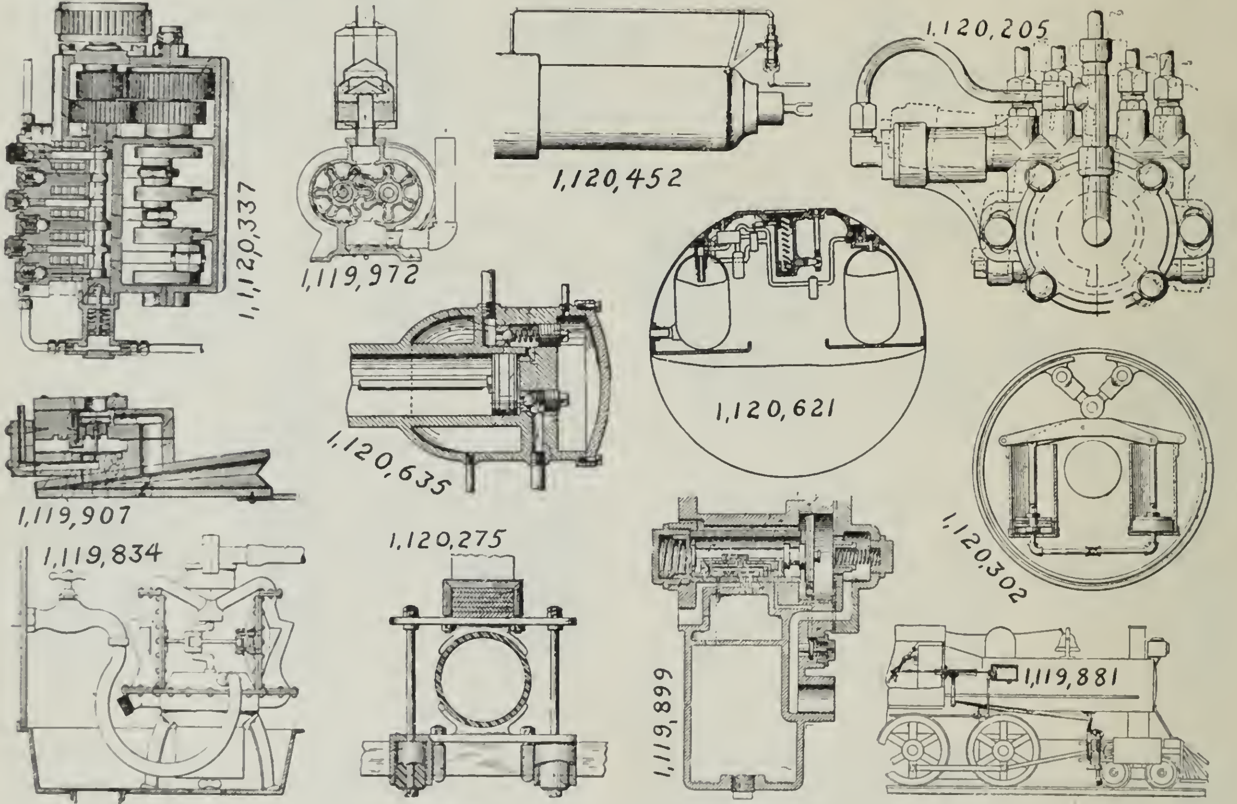
1,120,130. VACUUM CLEANING MACHINE. Secondo L. Casella, New York, N. Y.

1,120,205. STARTER FOR GAS-ENGINES. William Kelly, Detroit, Mich.

1,120,621. FLOATING SUBMARINE MINE. John Gunnar Lindmark, Eskilstuna, Sweden.

1. A floating mine comprising in combination, a regulating vessel, a pressure vessel, an intermediate vessel, connections and valve means for leading air from said pressure vessel to said regulating vessel through said intermediate vessel, and automatic hydrostatic means for controlling the action of said valve means, said valve means and said automatic means being so arranged as to connect said pressure vessel with said intermediate vessel when the mine is above a certain depth and to connect said intermediate vessel with said regulation vessel when the mine is below a certain depth, and being arranged also to cut off said intermediate vessel from said pressure vessel at the time the intermediate vessel is connected to the regulating vessel.

1,120,635. COMPRESSOR FOR AMMONIA SYSTEMS. John L. Vidar, Los Angeles, Cal.



Pneumatic Patents December 8.

1. In an apparatus of the kind described, the combination of a source of compressed air, a multiple cylinder gas engine, a distributer, a passage leading from each of the cylinders of said gas engine to said distributer, a valve adapted to open and close all of said passages, a valve adapted to be actuated by the operator between said source of compressed air and said distributer, and means whereby the pressure of the compressed air actuates the first named valve to open all of the passages between said distributer and the cylinders of the engine when the valve between the reservoir and distributer is open.

1,120,275. PNEUMATIC DEVICE FOR THE RUNNING-GEARS OF VEHICLES. John Caldwell, New York, N. Y.

1,120,302. AIR-BRAKE. Arthur J. Gaulin and Arthur Van Wyke, Charleston, Mass.

1,120,337. STARTING-MOTOR AND COMPRESSOR. Walter H. Shimpf, New York, N. Y.

1,120,452. FLUID-PRESSURE-RELEASING VALVE. Arthur O. Curry, San Bernardino, Cal.

DECEMBER 15.

1,120,673. APPARATUS FOR INHALATION PURPOSES. Hugo Bayer, Vienna, Austria-Hungary.

1,120,818. DEVICE FOR WASHING AIR. Alfred C. Johnson, Winters, Cal.

1,120,828. FUEL-SUPPLY SYSTEM AND STARTER FOR EXPLOSIVE-ENGINES. Benjamin F. Lowry, Austin, Tex.

1. A fuel supply system including an internal combustion engine, a fuel inlet communicating therewith and an exhaust outlet leading therefrom, a storage tank communicating with the said engine fuel inlet, a compressor communicating with and adapted to deliver compressed gases to said storage tank, said engine exhaust outlet communicating with said compressor, fuel and air pipes communicating with said compressor, a pressure relief valve communicating with said exhaust pipe, and a governor controlling the pressure within said storage tank.

1,120,833. FLUID-MOTOR AND RETARDING DEVICE THEREFOR. James F. McElroy, Albany, N. Y.

1,120,986. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,121,218. AUTOGENOUS BURNER. Ernest Wiss, Griesheim, Germany.

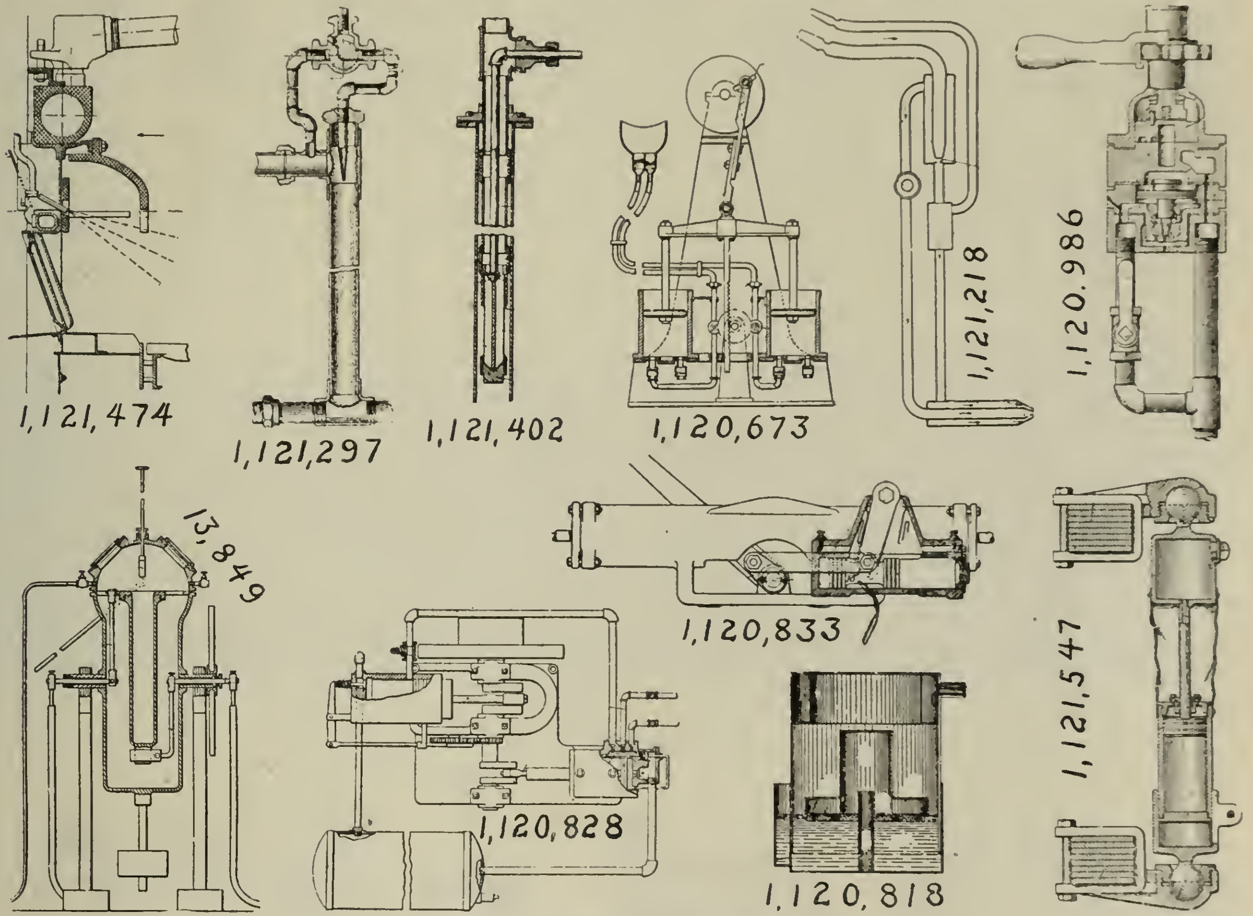
1,121,297. ASPIRATING APPARATUS. Henry J. Schmitt, Pittsburgh, Pa.

1,121,402. COMPRESSED-AIR WATER ELEVATOR. Horace L. Riley, Richwood, W. Va.

1,121,404. STOPPING APPARATUS FOR MOTOR-CARS. Henry C. Ruf, Easton, Pa.

1,121,474. LIQUID-FUEL FURNACE. Georges Eugene Canhac, St-Denis, France.

1. In a furnace provided with a fuel burner, the combination therewith of means to supply a blast of air to the jet issuing from the burner, said means provided with an opening located directly above the jet and extending throughout a part of its length, said opening substantially conforming in shape to the horizontal cross section of the jet.



Pneumatic Patents December 15.

1,121,547. SHOCK-ABSORBER. Arthur A. Barber, Detroit, Mich.

13,849. (REISSUE). APPARATUS FOR MELTING AND MIXING METALS IN VACUO. William Speirs Simpson, London, England.

DECEMBER 22.

1,121,608. APPARATUS FOR FEEDING MOLTEN GLASS. Orville A. Bridges, Zanesville, Ohio.

1,121,710. TRACK-SANDING APPARATUS. Albert H. Carnes, St Louis, Mo.

1,121,810. PNEUMATIC-STACKER HOOD. August P. Determann, Lyons, Iowa.

1,121,845. APPARATUS FOR SUPPLYING HUMIDIFIED AND SCENTED AIR. Frederick W. Kallusch, Long Beach, Cal.

1,121,956. GOVERNING MECHANISM FOR CENTRIFUGAL COMPRESSORS OPERATING IN PARALLEL. Richard Troger, Charlottenburg, Germany.

1,122,039. PNEUMATIC DUST-COLLECTOR Joseph J. Smith, New York, N. Y.

1,122,085. COMPRESSOR. Addelbert Dudgeon, Latrobe, Pa.

1,122,099. PORTABLE LIQUID-SPRAYING APPARATUS. William H. Gilmour, Liverpool, England.

1,122,105. MOLDING-MACHINE. John A. Guy, Watervliet, N. Y.

1,122,142. APPARATUS FOR DRYING MILK John D. McIntyre, New York, N. Y.

DECEMBER 29.

1,122,253. AIR-BRAKE SYSTEM. Harry D. Carroll, Norristown, Pa.

1,122,395. COMPRESSOR-UNLOADER. Lorenz Iversen, West Homestead, Pa.

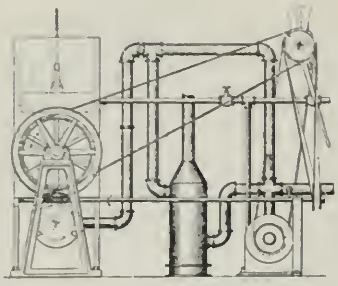
1. The combination of a compressor cylinder, a relief valve in communication with the cylinder intermediate the cylinder ends, automatic means for operating the relief valve when predetermined cylinder discharge pressure has been attained, and a piston within the cylinder and adapted to close the communication between the cylinder and valve during a portion of the piston stroke.

1,122,421. PNEUMATIC PROJECTOR FOR CONFETTI AND THE LIKE. Thomas G. Redington, Medfield, and John L. E. Pell, Great Barrington, Mass.

1,122,436. AUTOMATIC SLACK-ADJUSTER. Richard C. Swartzwelder, Edgewood, Pa.

1,122,566. PORTABLE FIRE-ESCAPE. Walter F. Bailey, Los Angeles, Cal.

2. In a fire escape, a plurality of alined cylinders formed with ports in their ends, pistons in said cylinders, a crank shaft connected to said pistons, a cable carrying reel geared to said crank shaft, a portable frame supporting the cylinders, crank shaft and reel, and a valve for controlling the passage of air to and from the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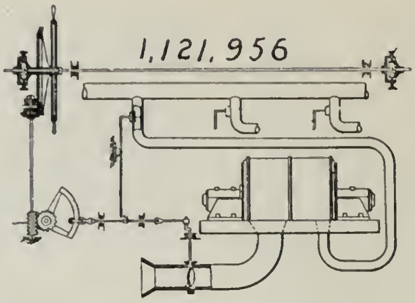
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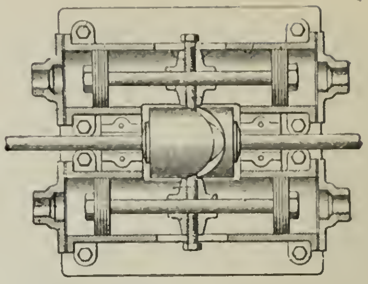
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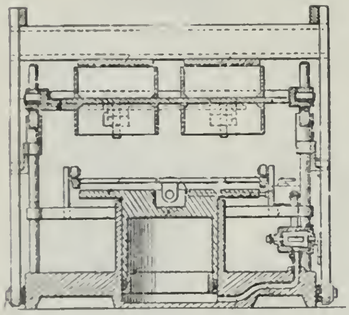
1,122,105



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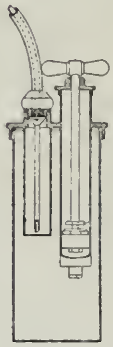

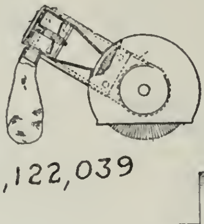
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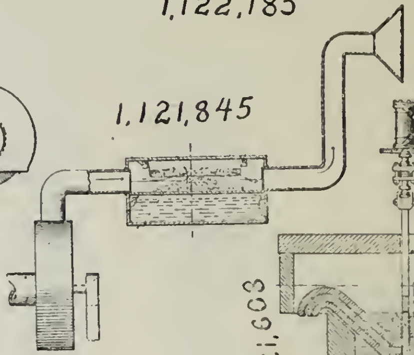
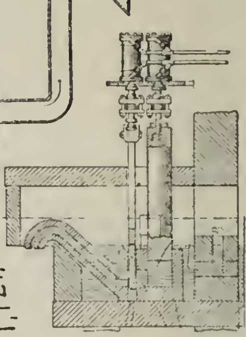



1,121,603

Pneumatic Patents December 22.

cylinders through the ports, whereby the speed of rotation of the reel may be varied or its movement inhibited, comprising a cylinderical valve member formed with a plurality of longitudinally extending grooves of various cross-sectional areas adapted to be moved in and out of register with the ports on the rotation of the valve.

1,122,629. PNEUMATIC - DESPATCH - TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.

1,122,630. FLUID - OPERATED PERCUSSIVE TOOL. Caid H. Peck, Waverly, N. Y.

1,122,638. PRESSURE-CONTROLLED VALVE. Ward Raymond, Easton, Pa.

1,122,877. PNEUMATIC TRANSMISSION. Frank A. Dowler, Lawrence, Kans.

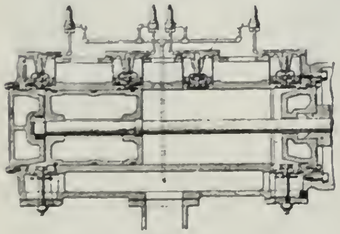
1,122,886. VACCUM MASSAGING DEVICE. Thomas H. Ellis, St. Louis, Mo.

1,123,001. FLUID-PRESSURS BRAKE MECHANISM. Richard A. Philbrick, Fredonia, Kans.

1,123,114. MEANS FOR MOISTENING THE AIR USED IN EXPLOSION-ENGINES. Charles E. Diehl, Des Moines, Iowa.

1,123,155. ART OF DUST-HANDLING. Whitford W. Woodley, Elizabeth City, N. C.

2. The method of handling miscellaneous materials in long blow pneumatic systems, which consists in creating in a long blow pipe of small cross sectional area an air current of constant volume, charging the pipe with relatively concentrated masses of miscellaneous material wherein the particles of various qualities are intermingled, and initially spacing the masses apart in the pipe to afford spaces for the lagging of retarded particles of each mass without reducing the velocity of the materials-content of the piping as a whole.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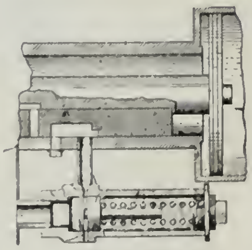
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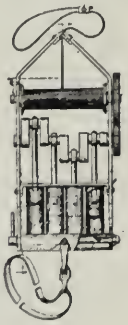

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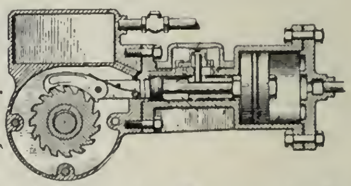

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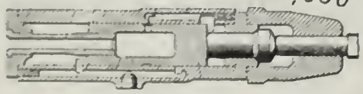

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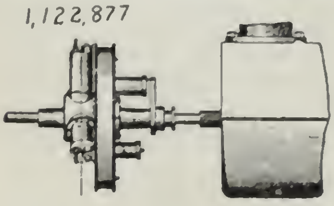

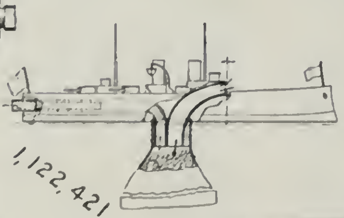
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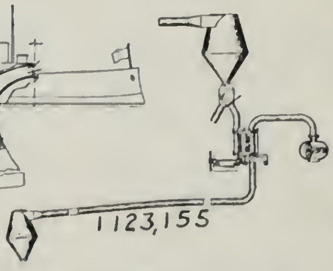
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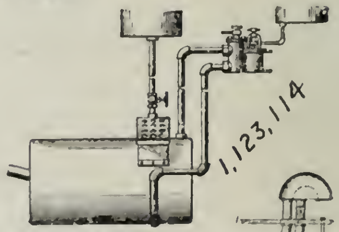
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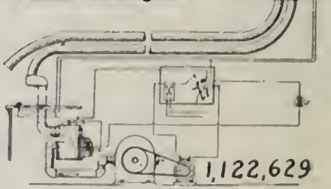
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Pneumatic Patents December 29.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XX MARCH, 1915 No. 3

FIG. 2. TYPICAL VIEW OF COAST NEAR GLOUCESTER, MASS.

THE BRASHER AIR BREAKWATER

The destructive storms which have recently been playing fresh havoc along the coast of New Jersey, urge the necessity, and incite to the study of, the means available for protection.

In our issue of April, 1907, attention was called to the scheme of Mr. Philip Brasher for robbing the waves of their destructive force by giving to the water a certain elasticity in place of its too familiar unyielding solidity, which is accomplished by distributing compressed air up through the water from pipes laid along the bottom at a sufficient depth and parallel to the shore to be protected.

Fig. 1, on the following page tells the story in a way that renders words unnecessary. The compressor can be located wherever most convenient, or compressors used for other purposes can be connected to for emergent use. As the services of such a compressor would never be constantly required, although it should be ready to operate at short notice, an oil engine drive would seem to commend itself.

It must be conceded that this scheme has never been tried as extensively and completely as it would seem to deserve, although Mr. Brasher has followed it up until the present and has the encouragement of considerable success even with the crude arrangements which he has hitherto been able to employ.

We are enabled now to give an account of various actual experiences in the development and application of this device as communicated to us by Mr. Brasher. It will be noted that there has been in no case what might be considered a complete and altogether satisfactory

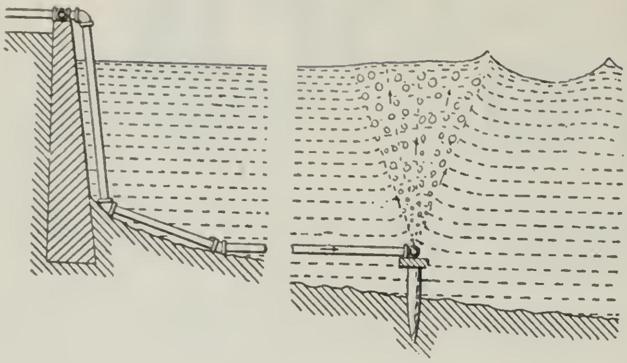

FIG. I.

installation such as the scheme would certainly seem to deserve. For instance, no compressor has been actually installed for this special service, but air has been taken for experimental purposes from compressors already in use for other lines of employment.

In the same year in which the article referred to appeared in our columns experiments were conducted at the plant of the Morse Dry Dock and Repair Co., New York Bay, for the purpose of determining suitable sizes of pipe, diameter and arrangement of holes and the actual air consumption under given conditions.

In the summer of 1908 there was a convention of the Master Car Builders' Association at the Million Dollar Pier, Atlantic City, and among the exhibits was a compressor of the Chicago Pneumatic Tool Company, and air was taken from this. There was over half a mile of pipe, 700 feet of which was 1 in. pipe, by no means all air tight, but which delivered between 50 and 100 cu. ft. of free air per minute to be discharged from the line of pipe laid out under the waves. Even this small volume of air had a decided effect on the ground swell running at the time.

The next trial was at Crotch Island, Maine, taking air from the compressors of the Benvenue Granite Company. They had two Ingersoll-Rand Compressors, one of 5400 and the other of 2700 cu. ft. free air per min. They had to go out more than a quarter of a mile from shore to get outside the reefs, etc. In a depth of 46 ft., 300 ft. of 4 in. pipe was laid, perforated with ¼ in. holes 6 in. apart, experience having determined this size and spacing to be most satisfactory. Mr. Moon, superintendent of the quarry reported that on the day of the trial waves were rolling in so high that the spray was flying over the tops of the trees along the shore. Fifteen minutes after the air was turned on he could paddle around in a canoe in the smooth water that the "air break water" furnished.

While Mr. John Arbuckle was busy with the salvage of the "Yankee," on Hen and Chickens reef in Buzzard's Bay, Mass., he telegraphed to Mr. Brasher to come and assist in

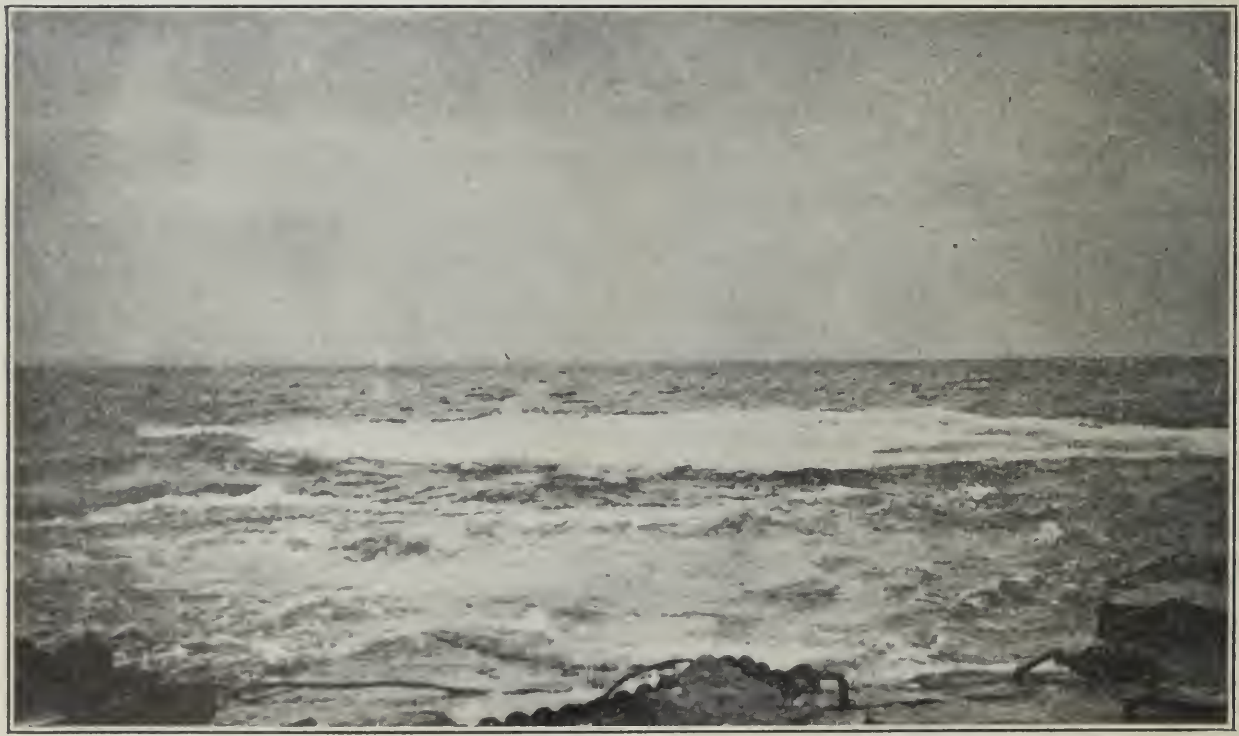

FIG. 3. AIR JUST TURNED ON.

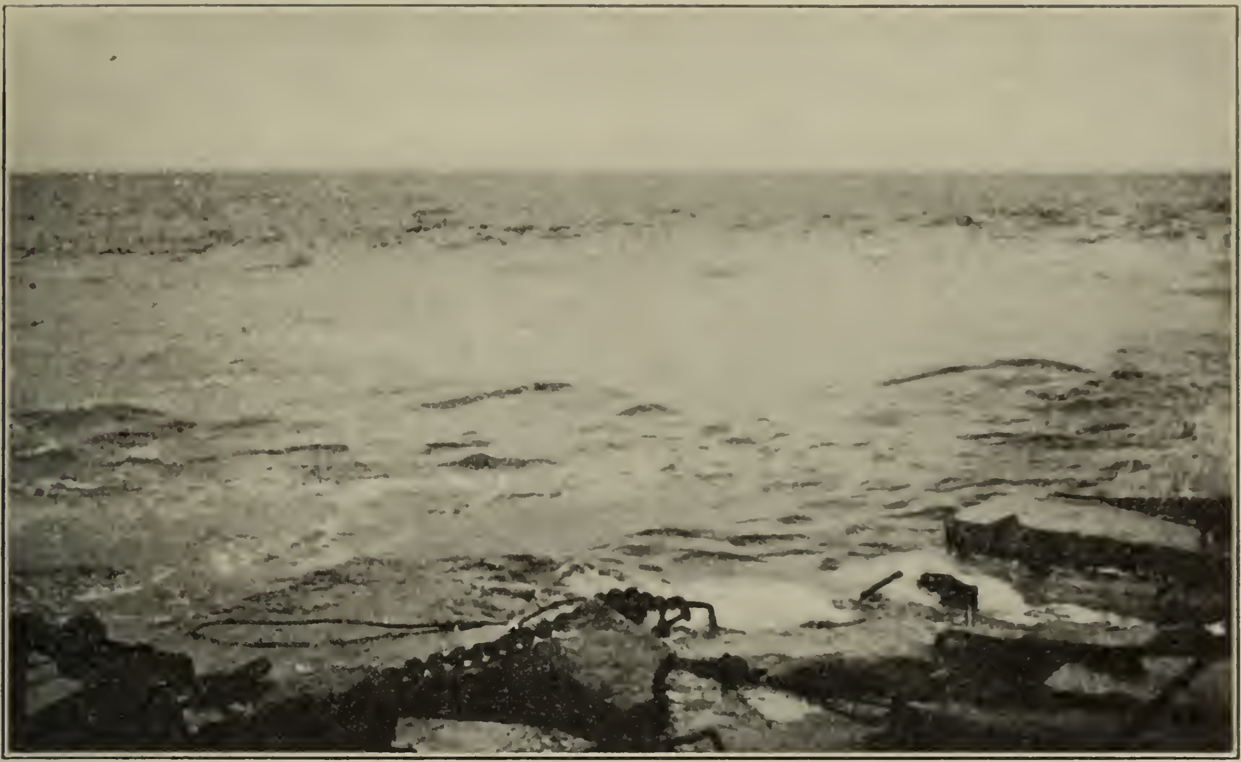

FIG. 4. SMOOTHING EFFECT OF THE AIR.

protecting her. Several different sections of air pipe were put out in this case, only one of which is here particularly referred to. This was about 100 ft. long, with the air holes as before, about 70 feet from the vessel amidships and parallel with the hull. There were three Ingersoll-Rand compressors on the ship and the smallest of these was connected by 3

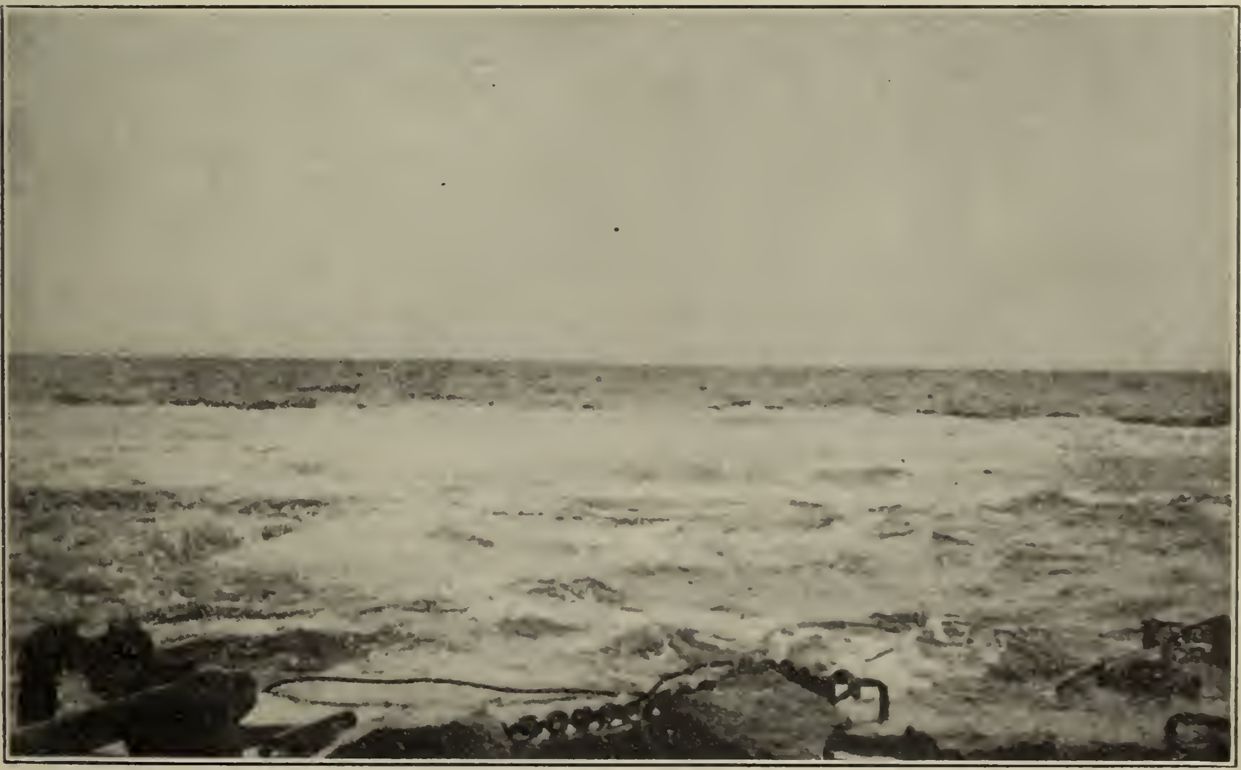

FIG. 5. AIR SHUT OFF AGAIN

in. hose to the submerged pipe without passing the air through the receiver.

On Dec. 2, 1908, in the morning, a heavy storm having come up over night, the waves were making a clean breech over the whole superstructure of the vessel and were estimated to be from 15 to 20 ft. high. It was impossible to stay on the weather side. The air was turned on and then it was possible to take pictures from the weather side. The compressor was making 67 revs. per min., and when Mr. Brasher suggested to Mr. Wotherspoon, who was in charge, that the compressor should be speeded up a little the response was: "What's the use? Its doing the work now."

John Anderson, a carpenter and handy man on the job, says in an affidavit: that "when the air was turned on the effect was instantaneous. The waves which had been breaking over the vessel to a height of 12 to 18 feet, became long swells which were quite harmless."

At Brighton Beach, Long Island, there was a Blaisdell compressor belt driven from a Westinghouse motor. Pipes were laid here which would protect 600 feet of shore front and these were maintained two years. The depth of water was 17 ft. with sandy bottom, and it was found that after considerable periods of inaction the pipes would not choke up but would be ready as soon as the air was turned on. It was only necessary to have a little higher pressure in starting.

Near Gloucester, Mass., there was a pier at which it was sometimes difficult to land, and here a Brasher breakwater was installed. Fig. 2 is a typical view of the coast. The photos following this were snap shots from the end of the pier. Fig. 3 was taken immediately after the air was turned on. In the foreground is the 4 in. pipe going down into the water, and the white space on the surface shows the extent of the air distribution. Fig. 4 was taken after the air had been flowing for a minute or so and Fig. 5 after the air was again shut off.

It has been determined that the amount of free air required is from 3 to 10 cu. ft. per min., depending upon local conditions, the pressure of course being determined by the depth of submergence.

It would seem that the cost of an installation sufficient to completely demonstrate the applicability and value of this device should not be prohibitive. A company, the Brasher Breakwater Company, 141 Broadway, N. Y. City, has been organized in the interest of the invention and is ready to submit propositions to those who should be greatly interested.

LIGHTNING FIRES A MINE BLAST

At one of the mines on the Rand there recently occurred an accident said to be unique in the history of electric blasting and resulting in the death of four men and the serious injury of three others. The men were leaving the bottom of the shaft after having connnected up the round of holes ready for blasting, and the sinking bucket in which they were being hoisted had reached a spot about 20 feet from the bottom when the whole round of holes went off. The force of the explosion blew the bucket and its occupents on to the platform about 50 feet above them. In the ordinary way the men would have been hoisted to the surface, and, after the usual precautions to ascertain that all the men had left the shaft, the connected holes would have been fired by the switch on the surface. The accepted explanation of the terrible accident is that a fierce flash of lightning during a thunderstorm which was raging at the time struck the ropes of the skip or the guide ropes, and that these acted as a conductor connecting with the cable or the wires at the bottom of the shaft.

MOVING PICTURES OF ANTHRACITE MINING

A private view of the motion pictures prepared by the United States Bureau of Mines, showing anthracite mining from the face of the chamber to the train carrying the coal to market, was recently held at Wilkes-Barre. The merit of these pictures, which are for the education of miners, is that in them all mine rules are observed and everything is done in the proper way. All safety precautions are taken as to lights, handling explosives, examining chambers, setting props and pulling down loose coal. These films will be furnished to operators by the Bureau of Mines at cost, and will be used to show to miners' institutes and schools, and probably later to the general public as an illustration of the great expenses and difficulties incident to anthracite mining. The series was prepared under the supervision of Charles Enzian, of the Bureau of Mines, who came in for much praise for his ingenuity in overcoming the many physical difficulties attendant upon the preparation of the pictures.

GOVERNMENTAL CONTROL OF BUSINESS, DOMESTIC AND FOREIGN

BY W. L. SAUNDERS.*

There has been no governmental control of business until recent years. The very looseness of the situation, resulting in such absolute freedom of action, led men to do things in business which they would not think of doing in private life. The interests of the whole community were sacrificed for the interests of a few. Private monopolies grew up even in the common necessities of life. The abuses among railway, utility corporations and private enterprises even, in certain well defined instances, were so flagrant that it became no longer a question among fair minded men that the hand of Government was needed to restrain the tendency to commercial distraction.

It is generally admitted that a public monopoly such as a railway or utility corporation, should in the public interest be strongly held, and when so controlled it becomes unnecessary to advocate government ownership. Individual and corporate business enterprises are, however, quite distinct from public monopolies, and they should be treated accordingly. In a general way we will agree that the less Government control is put upon business the more steadily will it flourish, that legislative influence tends to impede the movement toward concentration, and represents a one-sided economic disarmament.

Government operation does not leave adequate scope for that personal initiative which is indispensable for general economic progress, nor for the needful spirit of enterprise on the part of the managers. It tends to weaken incentive of private gain, the most powerful stimulant of all economic progress. It would make impossible the free and full development of the enterprise, efficient, far-sighted personalities to whose untrammeled initiative we owe so much.

The mining industry, so characteristic of American enterprise, has been developed to its full measure of productivity through the prospect of gain. In manufacturing the progress that has been most marked in volume and value is seen in those enterprises where the control of patents has stimulated capital and individual action to their highest accomplishment We have seen this in the steel industry, which grew most where advantage was taken of new inventions to improve the processes and apparatus. We see it in the great harvester industry, the commercial development of which was distinctively on lines of invention. It is true also in sewing machines, steam, gas and oil engines, pumps, mining machinery, in textile work, shoe manufacture, etc.

Why, then, should we limit progress by Government regulation of any kind? We have our experiences in this line. In the first place Government started in with a domestic policy, of protection and patronage which practically freed the American manufacturer in most times from foreign competition, and while doing this the welfare of the people at large was at first safeguarded by internal competition which was not interfered with. It was found possible, however, to throttle this competition by combinations and consolidations of interests, so as to put the public at large at the mercy of certain trusts, which threatened to become, and in some instances did reach the position of being private monopolies.

Here we have a reason for Governmental control at home, and that control is applied under a liberal and just reading of the Sherman law, which is now interpreted broadly to prohibit only such monopolies and practices as are inimical to the public welfare. The Clayton bill now supplements this law, aiming chiefly at private monopoly and outlining generally a code of business ethics to the principles of which there can be no more objection among honest men than to the Ten Commandments. A Federal Commission has been established to aid business men to quick action under the law and to prevent unfair methods of competition in commerce.

REGULATION OF FOREIGN TRADE

It becomes, therefore, our chief concern and question as to how far existing Government regulations affect foreign trade. The question as to whether or not Government regulation *should* affect foreign trade is another matter. Legal advice from those who have studied this subject, and who are most competent to interpret the situation, is to the effect that there is nothing in the Sherman Law which prohibits price fixing, pools and trade combinations of American producers in selling goods for delivery into foreign countries. The term

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*Extract from an address before the National Foreign Trade Association, St. Louis, Jan. 21-22, 1915.

"foreign commerce," which is used in the Sherman Law, is evidently intended to apply to importations and not to exportations, although both are involved in the broad term "foreign commerce." There is a large amount of business done in the United States in the sale of products of other countries.

The law, in caring for the public welfare and in preventing monopolies, includes imports as articles of domestic commerce. Apart from legal opinions, it would seem plain that the Government of the United States has no right or authority in the matter of sales made for delivery to foreign countries. It is not within its province to regulate them, as the concern and control of any country are limited to its own territory. Two men located, say, in Italy to promote the sale of American made tools have a perfect right to get together and fix prices and terms, so long as they do not violate the laws of the country in which they are doing business. Nor is it even necessary for competitors to be actually located at the foreign points of delivery, for so long as the proof exists that delivery is made outside the limits of the United States it seems plainly within the province of any one to cooperate to the fullest extent in negotiating sales.

Price fixing is not in itself immoral, nor is a monopoly immoral. They are both wrong when they are unfair or are contrary to the public welfare or when they are construed as unlawful acts, and in this case unlawful acts are such only as are unfair or contrary to the public welfare.

PLANCTON

One of the most brilliant achievements of modern biology is the demonstration of the vast variety, bulk, and importance of the living creatures, both animal and vegetable, which swarm thickly in the clearest sea-water, and are known collectively by the name of plancton. Since the ocean covers two-thirds of the surface of the globe, and since these aquatic forms of life exist throughout many fathoms of depth, instead of merely in a thin layer of earth and air as do terrestrial creatures, it is obvious that they are enormously superior in numbers and in actual "tonnage." But the very tiniest of these, the low vegetable forms which derive their nutriment directly from the water and its inorganic constituents, themselves become the food for slightly higher forms of animal life, and these in turn feed still higher forms, so that the humbler marine life is the ultimate provender of those food-fishes which supply so large and increasing a portion of the food of mankind. Millions of the planctonic creatures are either microscopic in size or so transparent as to be invisible ordinarily. However a pretty experiment demonstrates the presence of some of these tiny forms. It consists in placing a glass dish full of clear sea-water in a dark room and then allowing a beam of light to fall upon it. Just as such a beam will show the motes dancing in air it will show thousands of shining particles which are really living beings dancing in the water.

PERFECT VACUUM NOT YET

But within a one hundred and thirty millionth of it. No perfect vacuum can be even approached by any pump. After the mechanical piston pumps came the mercury pump, but that took a very long time. Then the Gaede pump, and the Geryck pump improved matters somewhat, but were not satisfying to scientists, and now we have a new device, ingenious, swift and reliable.

Suppose that we have a sealed tube containing air. If we place this in liquid hydrogen, the air in a few minutes becomes a solid in the bottom of the tube. If there were absolutely nothing but air in the tube, and if all the air were frozen we would have a perfect vacuum; but air contains what the chemist calls "traces" of several inert and hard-to-freeze gases, two of which are helium and neon. The tiny amount of these rare gases found in the air is of course left in the space, and so a perfect vacuum does not appear. But helium has been liquefied also. As liquefied helium is the coldest thing obtainable, it will not freeze any more of itself. To make the vacuum more complete, however, it was decided to put some charcoal into the tube. It had long been known that hot charcoal had the power to absorb or "occlude" gases; but little was known about its power when as cold as liquid air. A great surprise was in store for the first man to try it, however; for it was found that it absorbed a great deal more when very cold than when warm, in some cases seven or eight times as much. So the charcoal placed in the space absorbed a good part of the gases remaining, and the wonderful vacuum of 0.000000225 in. of mercury is obtained.

RETURN-PIPE COMPRESSED AIR PRACTICE

BY FRANK RICHARDS

I have before me a letter from a California correspondent who asks why it is that more has not been made of the "Cummings" system of compressed air power transmission. He says that from the results which have been actually attained by the system it could be advantageously employed in many places, especially as, besides the economy of it, there is no danger of fire or explosion, and it can be operated under water if necessary.

Notwithstanding that the return-air or two-pipe pumping system, for raising water by the direct pressure of air, is quite extensively and very successfully employed in different parts of the country, and that this system has been fully described in various publications, still I find that the essential principles of the "Cummings" system in its entirety are generally not well understood even where it happens to be known at all. Patented a full generation ago, it seems to have been exploited mostly in California, and it occurs to me that it may be quite worth while to call the attention of power users to it again.

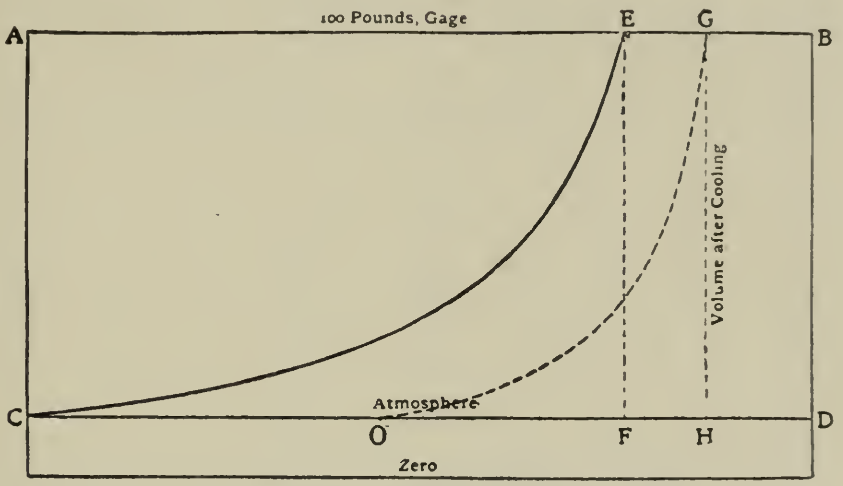


FIG. I. AIR BETWEEN O AND 100 LB. GAGE.

It is a rather curious thing that the new departure which this system represents, the use of higher pressures, is quite in line with the improvements in steam engines, in gas engines, especially of the Diesel type, and in electric practice. It may be claimed, however, that the two-pipe air system "goes them one better." In the compound or the triple expansion steam engine it seems to have been the last added portion of the pressure which has secured the economy, but still the entire range of the pressure from the bottom to the top has all been retained, while the compressed air system here to be spoken of retains and uses only the higher, and presumably the more profitable part, of the pressure.

The essential feature of the system is the constant maintenance of a high pressure upon the air employed. Instead of all the time compressing fresh atmospheric air up to, say 100 pounds gage, using it in the motor at that pressure, with or without expansion, and then exhausting the air into the atmosphere again, a constant intake pressure of, say, 100 pounds is maintained at the compressor.

This air is compressed to, say, 200 pounds, is transmitted to and is used in the motor at that pressure, and then is exhausted and carried back to the compressor at a pressure of 100 pounds to be compressed and used again, and so on continuously.

The accompanying diagrams, Figs. 1, 2, 3 are all drawn to the same scale for equitable comparison, and they may be studied together, although each represents an operation entirely distinct from and unrelated to the others; that is they are not successive stages of one operation. In each case the same volume of air fills the cylinder at the beginning of the compression, but the actual weights or quantities of air are very different, only Fig. 1 beginning the compression with "free air," or air at atmospheric pressure.

Fig. 1 represents the adiabatic compression of a given volume of air from atmospheric pressure, say 15 pounds to the inch, absolute, to a gage pressure of 100 pounds, or 115 pounds absolute. Fig. 2 shows the compression of an equal volume of air, but air with an initial pressure of 100 pounds gage, to a delivery pressure of 200 pounds, and in Fig. 3 an equal volume of air at 200 pounds is compressed to 300 pounds.

In each case the initial volume of air compressed is represented by the area of the rectangle ABDC. When the air has been compressed to the gage pressure specified in each case its volume is represented by the area EBDF, and this will be the volume assumed to be discharged into the pipes and receiver. As we are speaking now from the purely theoretical view-point nothing is said about the clearance losses or other allowances to be made in practice.

It is well understood that the operation of compression invariably increases the temperature of the air very much, but this temperature it is impossible to maintain, and, unless reheating is employed, the air is never used at the high temperature at which it is delivered by the compressor. As the air cools to normal temperature before it is used, its volume being reduced proportionately, the actual volume available for use is represented by the area GBDH, this being in Fig. 1 only about an eighth of the initial volume, and not much more than one-half the volume EBDF as delivered by the compressor.

The air delivered under either compression represented may be said to have equal working value, volume for volume, the available pressure being 100 pounds in either case, the air in Fig. 1 at 100 pounds working against atmosphere only, the air in Fig. 2 at 200 pounds, working against a back pressure in the return pipe of 100 pounds, and that in Fig. 3 at 300 having a back pressure of 200 pounds.

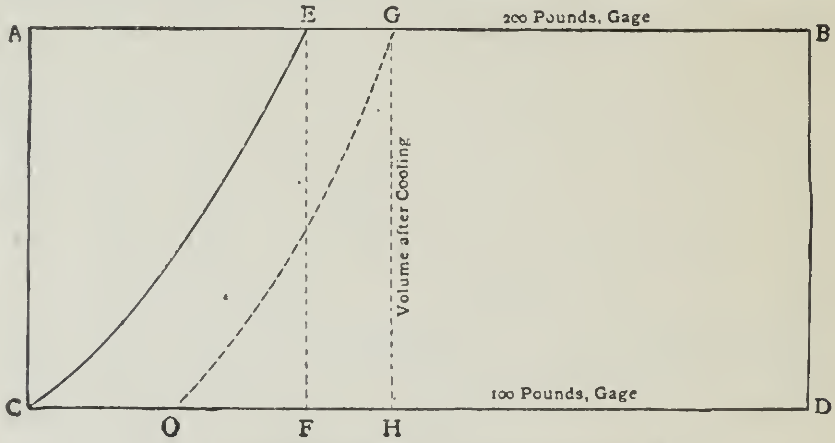


FIG. 2. AIR BETWEEN 100 AND 200 LB. GAGE.

In compressing air from 100 to 200 pounds, as in Fig. 2, the temperature of the air is not raised nearly as much as in Fig. 1, and consequently the shrinkage in cooling from volume EBDF to volume GBDH is proportionately much less than in Fig. 1. The volume GBDH, here available for work is more than one-half the initial volume ABDC, or four times the volume available in Fig. 1. At the same time it is to be noted that the mean effective pressure in the compressor cylinder for the stroke, which is the measure of the actual work of compression, is decidedly less than double that of Fig. 1. Getting fully four times the available volume for less than double the power employed certainly looks like doubling the efficiency by halving the relative cost of the compression.

In Fig. 3, compressing the air from 200 to 300 pounds, the heating of the air is still less and the consequent shrinkage by cooling also is less. The available volume delivered, GBDF, is five times the corresponding volume in Fig. 1, while the mean effective pressure required for the compression and delivery of the air is less than two and one-tenth as much, which seems to be decidedly more than doubling the efficiency.

It has been assumed in each case above that the initial air temperature is 60 degrees Fahr. With the same increase of 100 pounds in pressure the final temperatures will be 485 degrees, 163 degrees and 121 degrees the rise of temperature being, respectively, 425 degrees, 103 degrees and 61 degrees. The enormous rise of temperature in compressing from atmospheric pressure has led to the general adoption of two-stage compression, with intercooling of the air, thereby gaining something in economy, avoiding the overheating of the surfaces the burning of the lubricants and the danger of fires and explosions. With the heating that occurs in Figs. 2 and 3 there is no necessity for employing the two-stage compressor, and little possibility of any increased economy through its employment.

The ratio of final and initial absolute pressures is: in Fig. 1, 7.666; in Fig. 2, 1.869; in Fig. 3, 1.465. The ratio of the volume after cooling to 60 degrees, or the volume available for use, to the initial volume is: In Fig. 1, .1304; in Fig. 2, .535 and in Fig. 3, .6825. The relative costs of compression, as measured by the power used, or the mean effective pressures for the compression divided by the volume after cooling, are: in Fig. 1, 41.6÷.1304=319; in Fig. 2, 78.88÷.535=147; and in Fig. 3, 86.83÷.6825=127. Here the ratio of the cost in Fig. 1 is 319÷147=2.17, and of Fig. 1 to Fig. 3 it is 319÷127=2.51.

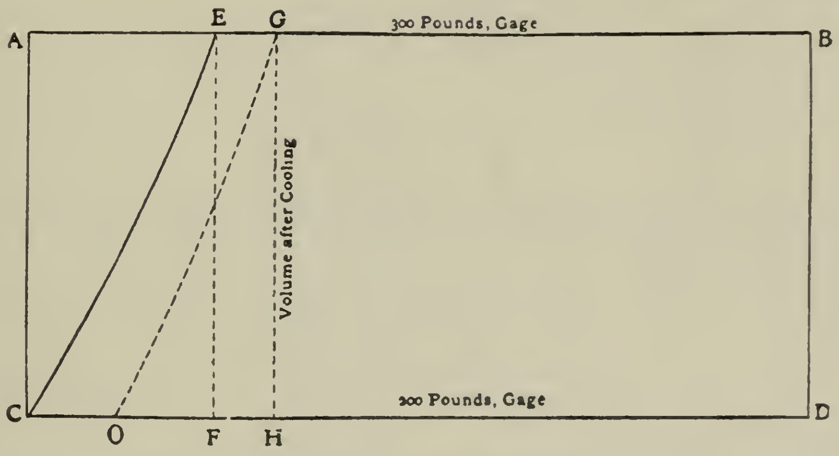


FIG. 3. AIR BETWEEN 200 AND 300 LB. GAGE.

It is understood that wherever this air is used—that is the air of Fig. 2 or Fig. 3—whether for driving a rock drill, for a steam pump or an air motor of any kind, the air instead of being discharged into the atmosphere, as it would be from Fig. 1, is piped back to the compressor with only 100 pounds of its pressure used, then, volume for volume, the air used would be of the same power value in either case if not used expansively. As the available volume delivered as shown in Fig. 2 is four times that in Fig. 1, a compressor of one-fourth the capacity, or at equal piston speeds, with a cylinder one-half the diameter, will be sufficient for the work. The maximum unbalanced pressure against the piston would be no greater in one case than in the other, only it would be continued for a longer or a shorter portion of the stroke. There would be no additional strength required in any of the working parts of the machine, except that the air cylinder and air connections would have to be strong enough for the maximum pressure. As the same air is used over and over again in the two-pipe system, arrangements being made for making up leakage losses, there is no appreciable accumulation of moisture and no possibility of freezing up, even if sufficiently low temperatures should occur, which they do not. At the same time more or less of the lubricant is carried back and forth in the air and comes in contact with the working surfaces. As the system is a closed one, being entirely out of touch with the surrounding atmosphere and not affected by the local pressure, it will work at one altitude just as well as at another.

WHY THE SYSTEM IS NOT USED MORE.

Now as to why the system has not been more extensively employed: there is the fact to begin with that even yet it is not generally as well known and understood as it should be. Then evidently it would not be likely to be much used for intermittent work, such as the driving of rock drills, which are continually changing their location and where the maintenance of the return connection would cost in time and trouble enough to cancel the prospective advantage.

Apparently the best employment of the system would be for the driving of ordinary steam pumps, where constant pressure is usually required for practically the entire stroke. The air of Fig. 2, at 200 pounds pressure and 100 pounds back pressure, or the air at the higher pressures of Fig. 3 do not permit much profitable expansion in use. When used for rotative purposes in an engine or motor; the cut-off, as the compression diagram suggests, should never occur earlier than three-quarter stroke, so that the cut-off that may be accomplished by a good slide valve engine would be all that would be available in any case. In this respect the air as in Fig. 1 would have some advantage, as it, to secure the greatest economy should be cut off before half stroke, and a certain saving would be accomplished by the expansion which would not be possible where the higher pressures were employed.

There is a necessity for the compressor supplying the air and the engine or motor using the air to approximately keep pace with each other, not necessarily stroke for stroke, but so that, with the aid of suitable receiver capacity, the delivery and the return air pressures shall be maintained as constant as possible. This implies that the two working units of the system should be adapted to each other in capacity and that an automatic pressure governor should control the compressor. More extensive installations employing several units in a single system might simplify rather than complicate the problem.—*Power.*

WINDY WINDOW ADVERTISING

A common wire waste basket was set in the window upside down with an electric fan under it placed so as to force a current of air up through a wire mesh into the enclosed space of the inverted basket. Here were put a number of dollar bills, and when the fan was started they danced for dear life in the breeze. A placard at one side said "Count the Dollar Bills and Get One Free," and the rest of the window was dressed with timely novelties which were for sale inside. The dancing dollar bills speedily drew a crowd, and although it was practically impossible to count them, all day long there were willing aspirants before the window, who incidentally got a very good idea of the location and character of the store.

AIR COMPRESSORS FOR NEW YORK CITY TUNNEL OF THE CATSKILL AQUEDUCT

On the opposite page we reproduce from Engineering News a list of the air compressors employed for the construction of the tunnels of the Catskill Aqueduct within the limits of the City of New York. This table appeared in Engineering News Jan. 28, in the third of a valuable series of articles upon the Catskill Aqueduct by Walter E. Spear, Department Engineer, 250 W. 54th St., N. Y.

While the driving of the City Tunnel did not present as many difficulties and uncertainties as the sinking of the shafts, the excavation of the tunnel, in point of cost and length of time required, was the largest item of the entire undertaking, and the plant required to do the work, though in general of standard design, contained much that was unusual from the circumstances of the work in the midst of a large city. Realizing its responsibility to the community, the Board of Water Supply made every effort to minimize the annoyance which must result from the work in the vicinity of the tunnel shafts. For example, it was provided in the contracts that electric power be used as far as practicable in place of steam, in order to avoid the noise and dirt arising from the operation of steam plants. Electric power supplied by the New York Edison Co. and its subsidaries and by the Edison Electric Illuminating Co., of Brooklyn, was according ly used to drive all permanent equipment, including most of the compressor plants, all shaft hoists, pumps (except air-driven pumps), blowers and the motors on stone-crushing plants as well as those of the concreting plants later installed. Shafts and tunnels were lighted by electricity.

The difficulties and expense of conveying compressed air through the streets from one shaft to another led to the adoption of independent electrically driven compressor plants at each shaft, except in the northerly section, Contract 63, where conditions approximating those outside the city exist and a central steam-driven compressor plant was erected, and except in a section in Central Park where it was possible to supply three shafts of Contract 66 from a single electrically driven plant through air mains laid in the transverse roads and the sidewalk of Central Park West. The size, type and capacity of the compressor plants installed for tunnel excavation are shown in the table. This brings out the interesting conclusion that, with the losses of air that occur in the mains and in the drills and connections at the headings, and with the necessary use of high-pressure air for ventilation, not much less than 2000 cu.ft. of free air per min. should be provided, for tunnels of this size, in order to maintain sufficient pres-

Shaft	Prime Mover	Number and Type of Compressors	Nominal Capacity of Plant. Cu.Ft. of Free Air per Min. Compressed to 100 Lb. per Sq.In.	Number of Drills of Given Type Set Up Simultaneously in the Tunnels
1–5*	2 Keeler and 4 Heine water-tube boilers, 1600-hp.	2 Sullivan tandem-compound, two-stage, 2500 c.f.p.m., Type WC 2 Ingersoll-Rand cross-compound, two-stage, 2500 c.f.p.m., Class OC3	10,000	8 Sullivan 3¼″ 7 Ingersoll-Rand 3¼″ 20 Ingersoll-Rand 3¼″ 5 Jap
6	2 General Electric, 6600-volt a.-c. motors	2 Ingersoll-Rand		
	1 200-hp.	1 1050 c.f.p.m.; Imperial Type 10 BD	1,600	†† 5 Ingersoll-Rand 3¼″
	1 100-hp.	1 550 c.f.p.m.; Imperial Type 10 BD		6 Ingersoll-Rand 3¼″
7	3 General Electric, 6600-volt a.-c. motors	2 Ingersoll-Rand and 1 Sullivan		
	2 200-hp.	1 1150 Ingersoll-Rand c.f.p.m.; Imperial Type 10 BD 1 900 Ingersoll-Rand c.f.p.m.; Class NE1	2,300	** 9 Ingersoll-Rand 3¼″
	1 60-hp.	1 250 Sullivan c.f.p.m.; Class WJ4		
8	2 General Electric, 6600-volt a.-c. motors	2 Chicago Tool Co.		
	1 200-hp.	1 1050 c.f.p.m.; Type CBG	1,600	‡ 7 Ingersoll-Rand 3¼″
	1 100-hp.	1 550 c.f.p.m.; Type MCB		
9	3 General Electric 6600-volt a.-c. motors	2 Chicago Tool Co. and 1 Sullivan		
	1 200-hp.	1 1050 Chicago Tool Co. c.f.p.m.; Type CBG	1,850	14 Ingersoll-Rand 3¼″ and 3⅝″
	1 100-hp.	1 550 Chicago Tool Co. c.f.p.m.; Type MCB		
	1 60-hp.	1 250 Sullivan c.f.p.m.; Type WJ4		
10	2 General Electric 6600-volt a.-c. motors		1,600	14 Ingersoll-Rand
	1 200-hp.	1 Sullivan 1050 c.f.p.m.; Type WJ		
	1 100-hp.	1 Ingersoll-Rand 550 c.f.p.m.; Imperial Type LOBD		
11	2 General Electric 6600-volt a.-c. motors	2 Sullivan	1,600	14 Ingersoll-Rand 3¼″
	1 200-hp.	1 1050; Type WJ		
	1 100-hp.	1 550; Type WJ		
12	3 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand and 1 Sullivan		
	1 200-hp.	1 Ingersoll-Rand 1050; Type XB2		
	1 100-hp.	1 250 Ingersoll-Rand; Type NE1	1,550	**10 Ingersoll-Rand 3¼″
	1 50-hp.	1 Sullivan 250; Type WJ4		
13–14–15*	3 Westinghouse 400-hp., 6600-volt a.-c. motors	3 Sullivan cross-compound 2100 c.f.p.m.; Type Wn2	13–2,100 14–2,100 15–2,100	12 Sullivan 3⅝″ 12 Sullivan 3⅝″ 12 Sullivan 3⅝″
16	1 Crocker-Wheeler 360-hp., 6600-volt a.-c. motor	1 Ingersoll-Rand, two-stage, direct-connected; Type PE	2,100	‡6 Ingersoll-Rand 3⅝″
17	1 Crocker-Wheeler 360-hp. 6600-volt a.-c. motor	1 Ingersoll-Rand, two-stage, direct-connected; Type PE	2,100	12 Ingersoll-Rand 3⅝″
18	1 Crocker-Wheeler 360-hp., 6600-volt a.-c. motor	1 Ingersoll-Rand, two-stage, direct-connected; Type PE	2,100	12 Ingersoll-Rand 3⅝″
19	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	‡ 6 Ingersoll-Rand 3¼″ and 3⅝″
	1 164-hp.	1 900 c.f.p.m.		
20	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	12 Ingersoll-Rand 3¼″ and 3⅝″
	1 164-hp.	1 900 c.f.p.m.		
21	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	‡ 6 Ingersoll-Rand 3¼″ and 3⅝″
	1 164-hp.	1 900 c.f.p.m.		
22	2 General Electric 6600-volt a.-c. motors	2 Ingersoll-Rand, two-stage; Type PE		
	1 215-hp.	1 1300 c.f.p.m.	2,200	12 Ingersoll-Rand 3¼″ and 3⅝″
	1 164-hp.	1 900 c.f.p.m.		
23†	1 General Electric 6600-volt a.-c. motor 164-hp.	1 Ingersoll-Rand, two-stage; Type PE 900 c.f.p.m.	900	‡ 6 Ingersoll-Rand 3¼″ and 3⅝″
24†	1 General Electric 6600-volt a.-c. motor 164-hp.	1 Ingersoll-Rand, two-stage; Type PE 900 c.f.p.m.	900	‡ 6 Ingersoll-Rand 3¼″ and 3⅝″

tral plant for these shafts. Later each compressor at plant for Shafts 13, 14 and 15 was piped separately. † One heading only at this shaft.
ly one heading running full. †† Bench drilled from heading columns. ‡ Drilling in one heading only.

LIST OF AIR COMPRESSORS ON N. Y. CITY TUNNEL OF CATSKILL AQUEDUCT.

sure to drill up two headings simultaneously with piston drills of the largest size. For the independent plants at each shaft, the plan adopted on Contract 67, of two compressors, one smaller than the other, appeared to be preferable to a single unit, because the smaller of the two machines could be run more economically, when only a small amount of air was required, and one of the two could always be depended upon to be in operation. The amount of energy a single shaft required for all purposes during tunnel driving amounted to 40 to 50 kw.-hr. (54 to 67 h. p.-hr.) per cu. yd., exclusive of trimming, and the peak loads ranged from 300 to 400 kw. (400 to 535 h. p.)

THE BUREAU OF MINES WORKS FOR SAFETY

The life savers of the United States Bureau of Mines have, according to the statement of Dr. Joseph A. Holmes, the director, rescued more than one hundred entombed miners from certain death. More than this, he asserts in his annual report that volunteer rescuers in the employ of mining companies and trained in rescue work by the bureau have saved many other men. As a result of the example set by the bureau, rescue and first-aid organizations have been established at many mines and more than 1,200 sets of rescue apparatus have been purchased by mine owners. These stations are expected to save the lives of many men in the future.

The bureau in the furtherance of its work now maintains six mine rescue stations, eight mine rescue cars, and one rescue motor truck, located in the mining districts of the country. The cars visit the various mining camps and train the men in rescue work and also in first aid to the injured. This movement has reached the point that whenever there is a mine disaster it is now possible to obtain a sufficient number of trained volunteers to take care of the rescue in an orderly and systematic manner and without the great loss of life so frequently found among the rescuers in the past.

The work of the states in carrying out their part of this program in mine safety is being carried forward in a reasonably satisfactory manner. The states are already spending in their inspection and police-supervision work more than the Federal Government is spending in all of its investigations in behalf of mine safety. Thus, for example, a single state, Pennsylvania, maintains a well-organized and efficient inspection force at a cost of $213,000 each year.

"Many of the mine owners have begun a system of operations in which safety is considered of first importance. More than 170 mining companies have individually, or through the association of two or more companies, established seventy-six mine-rescue stations at which there are 1,200 sets of rescue apparatus besides the auxiliary equipment for first-aid and fire-fighting work. There are also twelve mine-rescue cars now operating by individual companies about their own properties.

COMPRESSED AIR FOR SAFETY IN TEXTILE MILLS

BY CHARLES C. PHELPS.

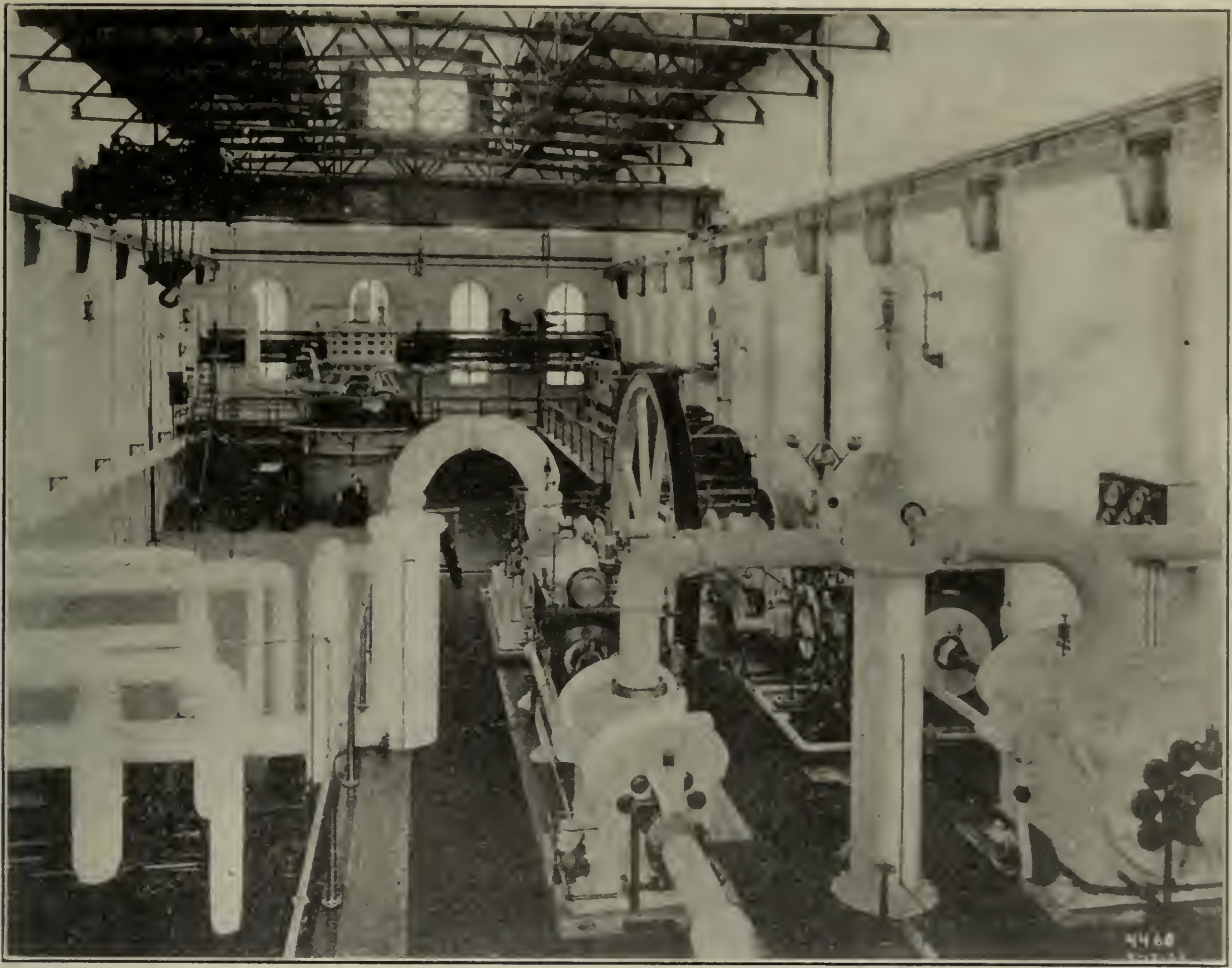
The greatest fire hazard in the textile mill lurks in the staple in course of manufacture. The next greatest hazard probably is found in the lint and dust which spread about every room where the manufacturing is conducted. This material finds its way into the most inaccessible places, and if permitted to accumulate, it furnishes an ideal medium for converting the smallest spark into a disastrous conflagration. Textile mill superintendents are aware of this very imminent danger and naturally attach great importance to the subject of mill cleanliness, largely on this account.

COMPRESSED AIR CLEANING.

The air jet has proven to be the most effective means of dislodging lint from the inaccessible places and thus minimizing, if not actually eliminating, one of the most serious sources of danger. Aside from the thoroughness of the compressed air method of cleaning, it as been found by experience that an actual economy can be effected, as the cleaning is accomplished more rapidly, most of the machines do not have to be stopped while being cleaned, and there is therefore an actual increase in production.

The air jet is used for cleaning practically every machine used in textile manufacturing. Pulleys, shafting, overhead beams, pipes and wires and ceilings may also be cleaned without the use of ladders, by air supplied through a nozzle screwed into the end of a long hollow tube. Unless overhead cleaning is done outside of regular working hours, the nearby machines must be stopped and dusted afterwards to prevent the lint from getting into the work. Less stoppage, however, is necessary than when the overhead cleaning is done with brooms and brushes, as the work is accomplished in much less time and more thoroughly. Compressed air is regarded as almost a necessity for cleaning electric motors. The lint gets into the air spaces of motors, raising the temperature and affecting the efficiency, hence frequent blowing out becomes necessary.

Compressed air cleaning was naturally first tried out in mills using air for other purposes, as for atomizing water for humidification, as in such places the economy to be gained from



AIR COMPRESSOR AT AMOSKEAG MILLS.

using a single piping system for a double service is apparent. Many mills are today equipped with compressed air for this double service; in addition there are several equipped with compressed air service for the sole purpose of cleaning.

PNEUMATIC HOISTS ECONOMICAL.

Where heavy lifting has to be repeated frequently or intermittently there is no device that can compare with the pneumatic hoist for the purpose. There are two general types, the cylinder hoist and the pneumatic motor hoist. These may be mounted in a fixed position or used as portable hoists by suspending them from trolleys running on an overhead I-beam rail. Both types are clean, convenient, foolproof, simple and absolutely without fire risk. The fire risk of a portable electric hoist, is a serious matter. There is always a possibility of the swinging feed wires fouling about some obstacle and causing a short circuit.

The economy of pneumatic hoisting is remarkable. The cost of operation will figure considerably under 1-1,000 of a cent per foot of lift per hundred pounds in the majority of cases.

Pneumatic cylinder hoists are used in textile mills for such purposes as transferring material from vat to vat in dyeing and bleaching, for raising and dumping trucks of bobbins upon the feeder aprons of conditioning machines and similar apparatus, for operating heavy doors and gates, for lifting heavy bales from tanks and vats, and for a number of similar operations where the lift is repeated over a fixed height.

Where the height of lift is variable, as in lifting bales and placing them on different levels in a warehouse, the air motor type is preferable. It is also more compact, requires very little headroom and has a much greater travel than the cylinder type. For this reason, it is also suitable for handling building material, for lifting machinery from floor to floor, for handling ashes and other waste material, etc.

The pneumatic drill is one of the handiest tools that can be used in a textile mill. Any operation that can be performed with a hand or electric drill or auger can be performed better and quicker with a corresponding pneumatic tool. The hand drill is slow and is very limited in power. The electric drill is fast enough but it limited to a single speed and the wires leading to it are a source of danger. The pneumatic drill can be run at any speed desired up to its rated limit and there is no risk of fire.

Besides using such tools in connection with hanging shafting, roughing out belt holes, cutting out holes in walls and ceilings for wires and pipes, for setting machinery, for drilling in metal and general repair work, the motors of these tools are often rigged up for special purposes, as for operating circular saws for cutting out worn mill flooring or roofing, for operating heavy valves, for cutting out old boiler flues and tubes and expanding new ones into the headers, for cleaning tubes in water tube boilers and for operating small machines of various kinds. Similar advantages are possessed by other pneumatic tools, as chipping and riveting hammers, which are great time and labor savers for general repair work.

PNEUMATIC MOTORS USEFUL.

The motors of pneumatic drills have been mentioned as being extremely handy for operations requiring small amounts of power. For similar power purposes on a larger scale, stationary pneumatic motors are commonly employed. These motors are particularly recommended for intermittent service in locations where the fire risk is high due to the proximity of inflammable material or to the absence of attendance. Familiar uses for these motors are for operating cranes, saws, grindstones, emery wheels, filter presses and other small machines and short lines of shafting. Mounted on portable frames, they are useful for shifting machinery and for hoisting building material, machines, etc.

The thorough practicability of compressed air as a source of power is further demonstrated by the fact that many industrial establishments are using compressed air locomotives exclusively for hauling material in bulk.

COMPRESSED AIR AS AN AID IN FIRE PROTECTION.

An attempt has been made to cite a few textile mill uses for pneumatic power and to show how the fire hazard is actually reduced by such applications. Presses, pumps, elevators and a variety of other apparatus are also operated by compressed air at times. The same statements covering the absence of fire risk apply to all such applications.

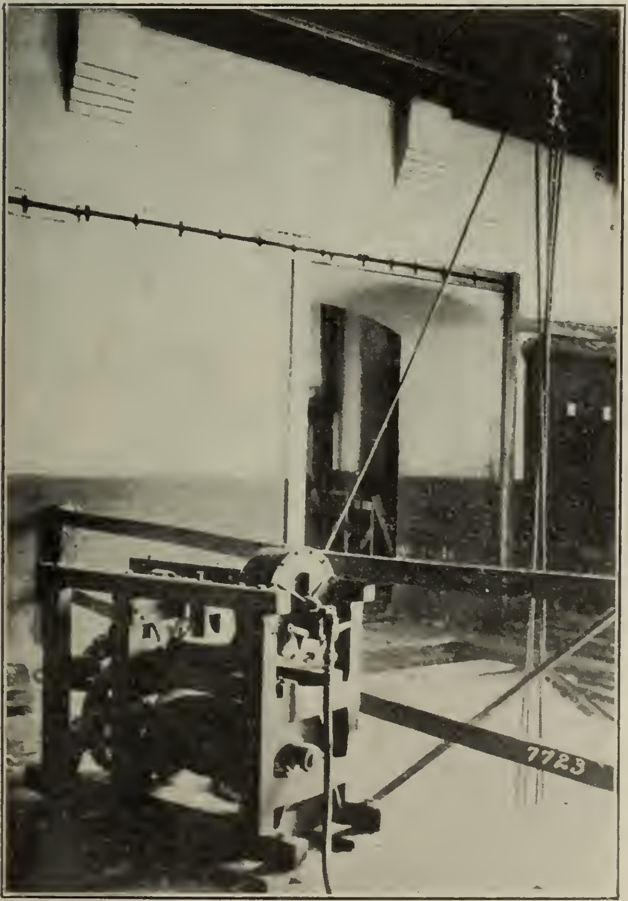
CLEANING MACHINERY IN A COTTON MILL.

The air lift is a favorite method of obtaining an abundant and reliable supply of pure water from deep wells. Due to the absence of working parts in the well, there is but little likelihood of such a system failing at a critical time, as in the event of a fire. Other systems of compressed air pumping, as the pneumatic displacement pump and the return air system, are also noted for their reliability, and hence are frequently adopted for the main or reserve water supply. The best fire extinguisher system made will be of no use should the water supply fail hence the reliability of the water supply should be the first thought of the factory superintendent.

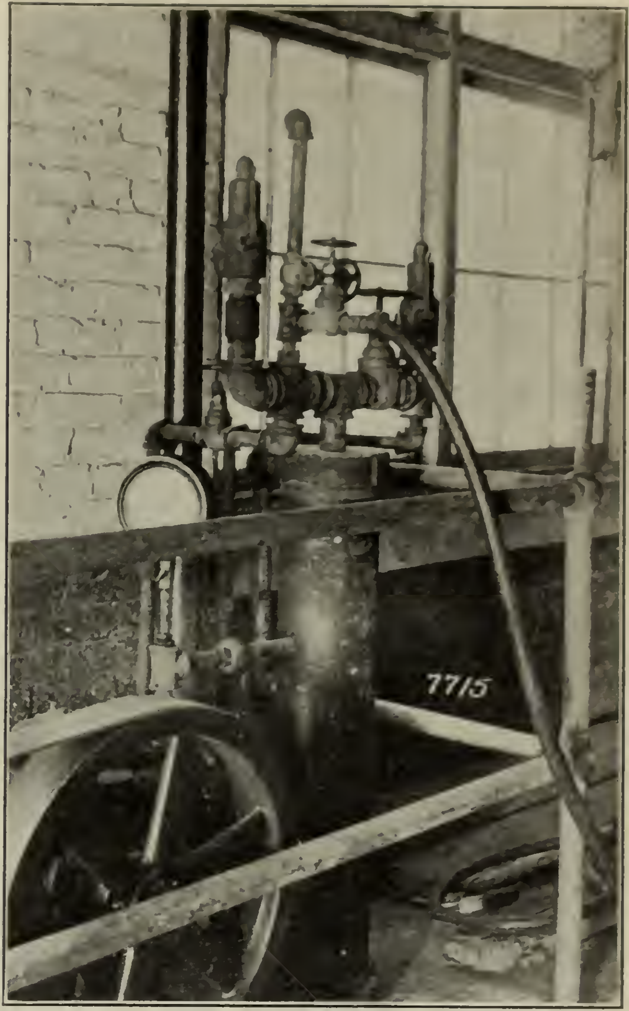
In unheated buildings, such as storehouses, it is necessary to employ some means to prevent the automatic fire extinguisher pipes from becoming frozen and inoperative during the winter months. The common practice is to keep the pipes throughout the building filled with air under pressure. This necessitates the use of a special valve, known as a dry-pipe valve. In a properly installed dry-pipe system, with periodical inspection, the protection is practically the same as with a regular sprinkler equipment.

Pneumatic whistles are used for fire alarms in many localities. By employing air-tight receivers with the whistles, the pressure is always ready to blow the whistle. A steam whistle for this purpose has the disadvantage that the boiler operating it is liable to be shut down at some time when most needed. Air whistles are sometimes worked in connection with electrically driven compressors, so connected that when the whistle starts to blow the compressor automatically starts up and maintains the required pressure in the receiver.

As the losses in transmitting compressed air over considerable distances are negligible, and as one or two large compressors are more efficient and require less attention than several small compressors scattered about a plant, it stands to reason that a large central air plant is preferable. Likewise when air is used for several purposes about a mill, the cost per operation is less than when it is used for a single purpose. It is for this reason, combined with the considerations of safety, that so many mills adopt compressed air for a number of purposes, after trying it out on a single application.



A PORTABLE AIR HOIST.



COMPRESSOR AND VALVES FOR ACID TRANSFER.

Sometimes compressed air is wanted for brief periods in different places around a mill. In such circumstances a portable electrically driven compressors furnishes a satisfactory solution. Such a compressor can be connected with the nearest electrical socket and operated either within or without the building in which the air is to be used.

There are many instances on record of mine fires and small explosions in which at least some of the men would have escaped in safety if they had taken the intake airway instead of the return. Even if the return is not strong with afterdamp and smoke when you enter it, you may be suffocated by a sudden increase of smoke or harmful gases before you can get out of it.

ELECTRICITY IN COAL MINES

In his annual report submitted to the Secretary of the Interior, Dr. Joseph A. Holmes reviews the investigations made by the Bureau of Mines to safeguard the miners from electrical accidents. Director Holmes makes the declaration that not only have many men been killed or injured from what are believed to be unnecessary electrical accidents, but indirectly electrical apparatus has been responsible for mine explosions and mine fires that have extensively destroyed both life and property.

He further says that, through the activity of the bureau in calling attention to dangers heretofore unappreciated in the use of electrical machinery, manufacturers have devised safer types of apparatus and states have enacted stricter laws governing electrical installations.

Much attention has been paid to the proper construction and use of electric and other safety lamps. Tests have been made to ascertain the comparative merits of different types of safety lamps, including their usefulness in furnishing light to miners, their relative safety, and their value in indicating the presence of explosive gas. The well-defined principles that govern the mechanical construction of a modern safety lamp have been largely exploited in this country by European manufacturers and covered by patents in this country. During the present year some of these patents have expired and in consequence American lamp manufacturers and lamp agencies have been inspired to develop new models. Already an improved safety lamp of American manufacture has appeared, and samples of others have been received by the bureau for examination and criticism. The bureau has studied all types of safety lamps on the market and as a result has prepared a schedule of official tests to be used in establishing a list of permissible safety lamps for use in gaseous mines.

At the beginning of the year the bureau's requirements for testing explosion proof motors had been prepared and published. The work was necessary because no successful explosion-proof motors had been developed in the United States. During the year only one motor was submitted for test, but this machine passed the tests successfully. It is believed that the bureau's approval will stimulate other manufacturers to renewed activity in producing such motors.

In the investigation of the ignition of coal dust by electric flashes, valuable results have been obtained. Coal-dust ignitions have been obtained under practical underground conditions with currents of surprisingly low voltage. The danger of dust explosions being started by such currents has been shown, but the work needs to be continued to determine the extent of the danger and how it may be nullified.

TESTING HAMMER DRILLS FOR MINE SERVICE—METERING THE AIR*

BENJAMIN F. TILLSON.

The hammer drill rightly receives the credit for having made the one man drill possible, and so many economies seem possible through the proper application of different types of hammer drills to various mining, quarrying and excavating operations, that an indication of the economies effected by the New Jersey Zinc Company at its Franklin mines may be of pertinent interest.

When this company commenced its trial of hammer drills in 1907, those tools had not been developed to one-fourth the capacity and refinement which they have at present. At that time it was frequently asserted that such a small tool, drilling holes of less diameter than the reciprocating rock drill, could not drill enough holes in a shift to permit the placing of sufficient explosive to break a tonnage of ore comparable with that produced by the "rock drills," that the placing of small holes inclined upward, at angles steeper than 40 degress above the horizontal, could not be expected to produce results equal to the large flat, wet or dry, holes in the breasted back of an overhand stope, and would only shatter the ground so as to make the back unsafe. In spite of these adverse opinions, however, the hammer drills first showed their superiority over both heavy and light reciprocating drills in raising and stoping, and then in drifting and quarry work. As a result, all of the reciprocating drills at the Franklin mines were scrapped three years ago, all of the mining work being accomplished with increased efficiency.

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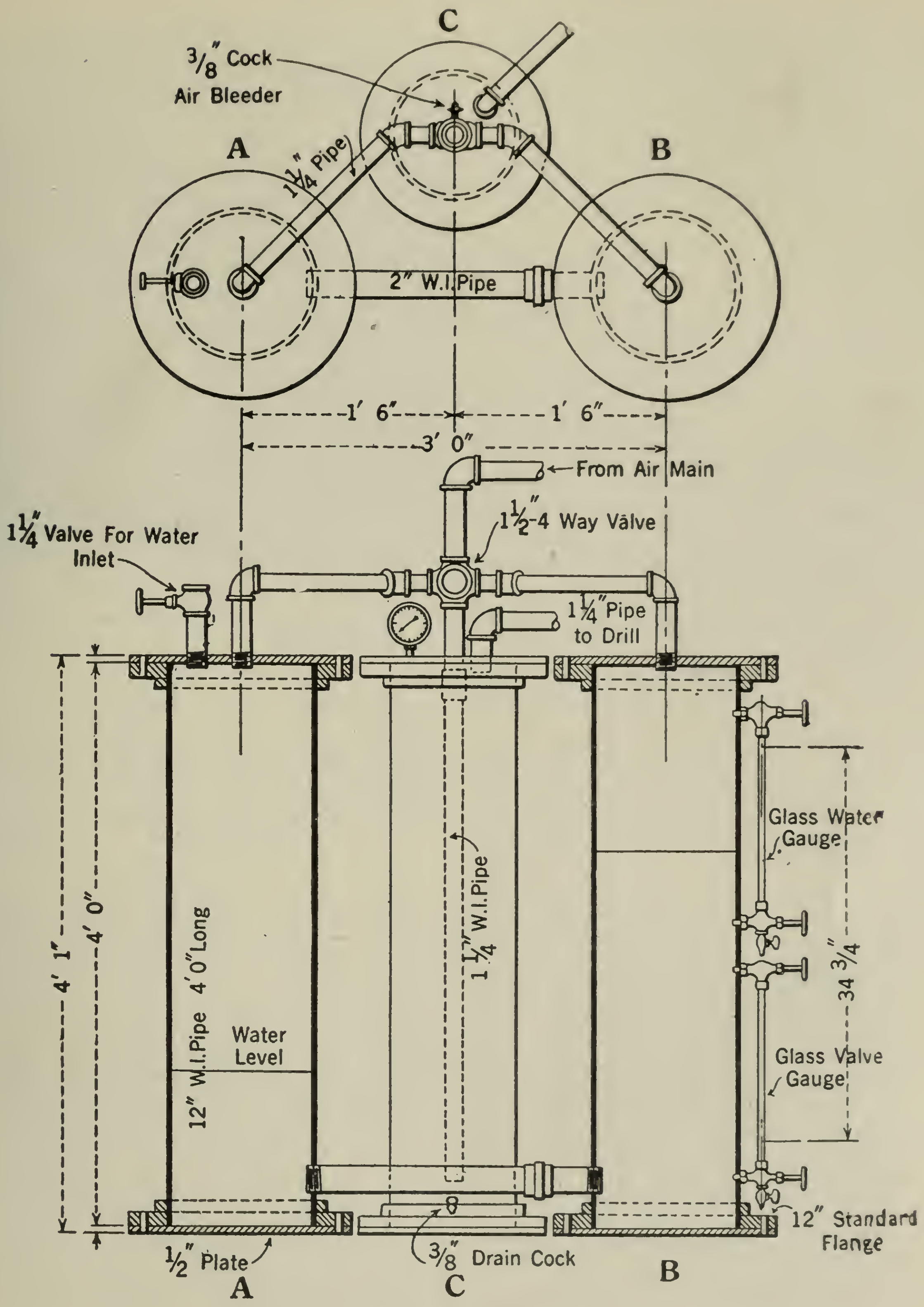
*Introductory portion of a paper before the American Institute of Mining Engineers, Feb., 1915.



AIR METERING APPARATUS.

With the advent of the hammer drills in this property, it was considered advisable to make comparative tests of all the tools accessible and it has since been the policy to investigate the merits of any advance of the drilling art, in order to get the maximum amount of work from the tools. The necessity of devising some means of standardizing drills tests, and of measuring the consumption of compressed air as well as the drilling speed was early realized.

The common test was to fill a measured air receiver with compressed air at a certain pressure, run the drill until the pressure had dropped to too low a figure, then compute from the time, drop in pressure and capacity of the receiver, the cubic feet of free air used. This was not considered a fair indication of the drilling capacity of a machine, since the performance of some drills did not vary directly with the absolute pressures of the compressed air.

It was, therefore, found expedient to build a water-displacement air meter with which the drill test could be carried on for any length of time without serious variations in the desired air pressure. This apparatus, as shown in the cut, consists of two tanks, half-filled with water, and made of 12-in. pipe with blank flanges, gauge glasses being mounted on one, a four-way cock connecting the compressed-air supply pipe with both tanks and the air line going to the drill. This device gives more accurate results than the common types of water or gas meters; and since any errors are due to the human element of reading the gauge glasses and reversing the four-way cock, they tend to be compensating throughout a number of tests.

The procedure is as follows: Air is drawn by the drill from the receiver *C*, which tends to trap any moisture carried over by the air from tanks *A* and *B* and assures a constant pressure while the four-way cock is reversed. In the arrangement as shown, the receiver draws its supply of air from the tank *B* and the water rises in this tank by virtue of the pressure of the air admitted from the air main through the four-way cock to the top of tank *A*, where the water is being forced downward and through the 2-in. connecting pipe to tank *B*. When the water has risen to a certain point near the top of the gauge glass in tank *B*, the four-way cock is reversed and the inlet air is supplied to the top of tank *B;* the drilling air is then taken from the top of *A* the reversal of the cock again being made when the water in tank *B* has fallen to a point near the bottom of the gauge glass.

A pet cock is placed on the top of tank *C* so as to permit the bleeding of air to bring the water columns to the desired point for starting a run, and another pet cock is attached to the bottom of the same tank in order to permit the drainage of water. For convenience in measuring and computing, a run is made on the supply of compressed air indicated by a certain number of reciprocations of the water columns between fixed points on the gauge glasses; the pressures are measured on the air gauge mounted on tank *C*, the length of time is taken by a stop watch, and the consumption of free air per minute is computed. Unless a pressure regulator is installed between the four-way cock and the receiver *C*, or else a globe valve at this point is operated manually to throttle the air so as to maintain a constant pressure, it is evident that the air pressure at the drill will vary in accordance with the water column supported by the inlet air pressure, but since the gauge-glass marks are in this instance set 34¾ in. apart, the maximum variation in pressures is about 1¼ lb. per square inch; it is difficult to find a pressure regulator which will control a pressure of 90 or 100 lb. per square inch to a closer degree of accuracy, and the sensitiveness of the drills to air pressure and the accuracy of time and distance measurements rarely exceeds this error.

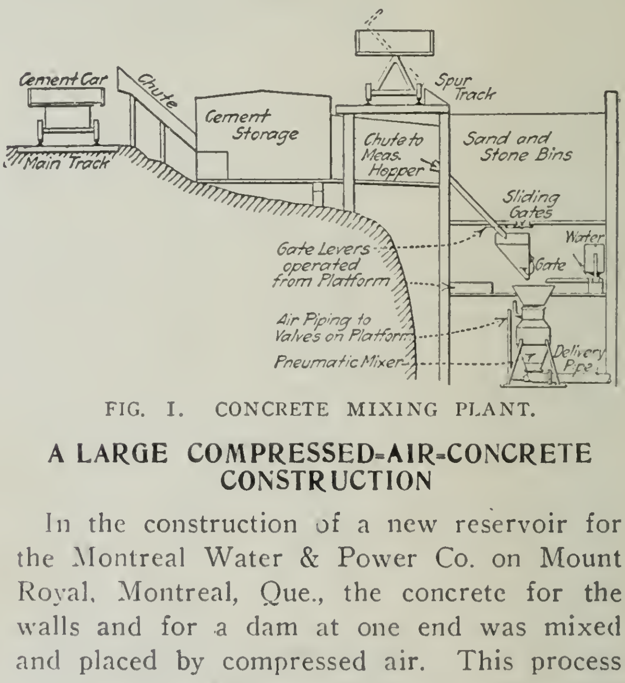


FIG. I. CONCRETE MIXING PLANT.

A LARGE COMPRESSED-AIR-CONCRETE CONSTRUCTION

In the construction of a new reservoir for the Montreal Water & Power Co. on Mount Royal, Montreal, Que., the concrete for the walls and for a dam at one end was mixed and placed by compressed air. This process is on the MacMichael system, and the mixer was furnished by the Pneumatic Concrete Mixing and Placing Co. for the contractors, Laurin & Leitch. F. H. Pitcher, General Manager and Chief Engineer of the Water Company, is in charge of the work.

The mixer had a capacity of ½ cu. yd. of mixed concrete per batch. The air was supplied from a steam-driven compressor located about 1,100 ft. from the mixer, in the central power plant, the air being led to the mixer

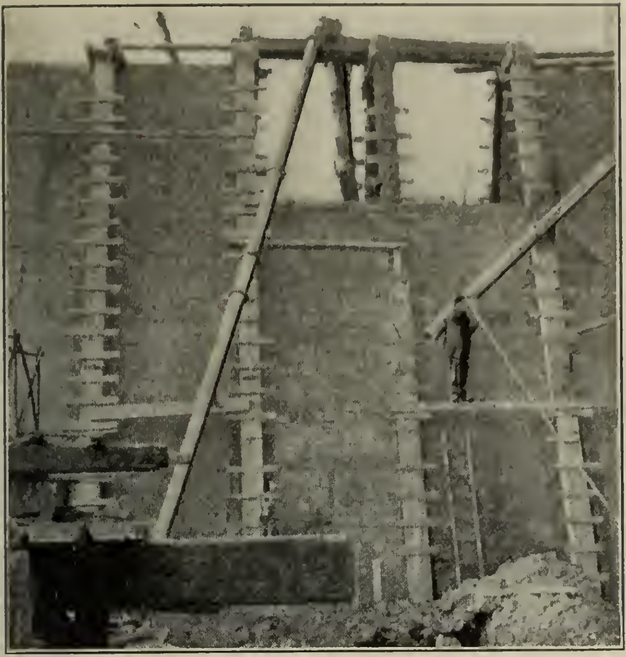


FIG. 2. PIPE TO TOP OF FORMS.

through a 6-in. line, with a storage tank at each end of the line.

Fig. 1 is an approximate section through the concrete plant, and shows the arrangement of tracks, cement shed, stone- and sand-storage bins, measuring hopper, water tank and pneumatic mixer. Cement was unloaded from electric cars on the main track, and the sacks were thrown from the cars into inclined covered chutes which led to the cement shed. For the unloading of sand and stone a standard-gage spur from the main line was laid on a short trestle running past the bins. Stone was dumped directly into the 200-yd. bin over the mixer from 6-yd. side-dump cars. Sand was delivered in box-cars and shoveled into a large auxiliary bin at one side of the mixer, the 90-yd. sand bin over the mixer being fed from the auxiliary bin with a bucket conveyor.

In the bottom of the storage bins were sliding gates, operated by hand levers, through which the materials were delivered into the two compartments of the measuring hopper immediately over the mixer. The cement was fed from the cement-storage shed by a gravity chute opening into the stone compartment of the hopper. On opening a gate, the contents of the measuring hopper would slide into the mixer and at the same time a measured amount of water was directed against the stream of falling materials, all falling into the mixer chamber together.

The concreting pipe ran from the mixer to the wall forms, where the pipe had a vertical rise of about 37 ft., and continued along the top of the forms around curves to the end. This pipe is 8⅝ in. outside diameter, made of steel, lap-welded, and weighs about 17 lb. per

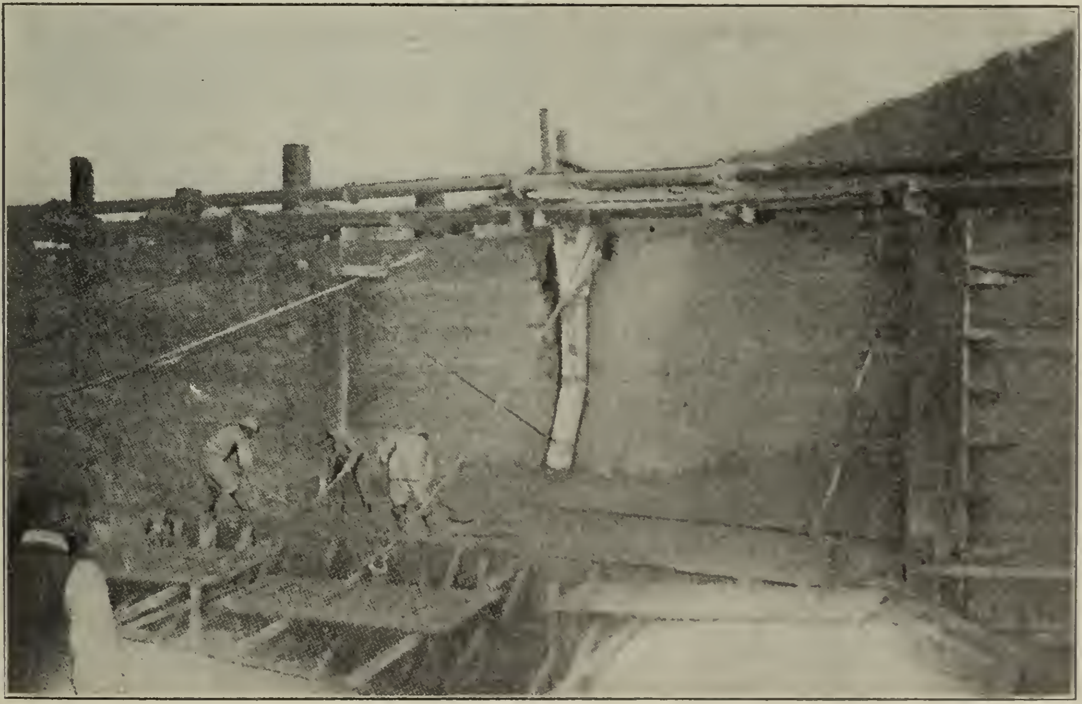


FIG. 3. CONCRETE DEPOSIT CHUTE.

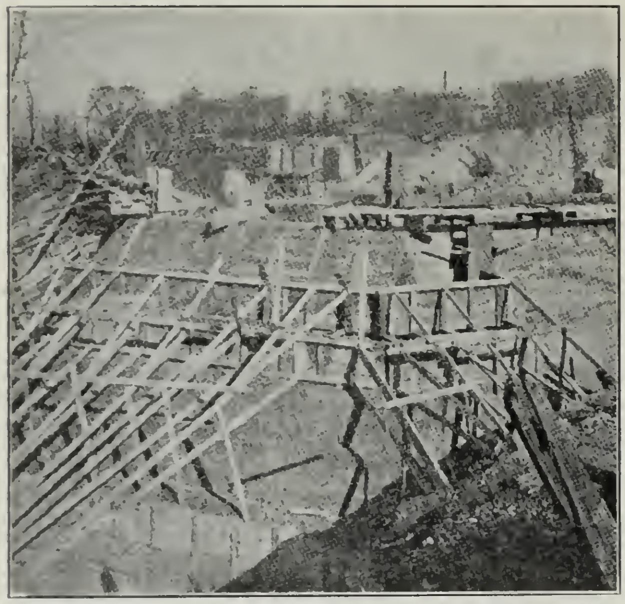


FIG. 4. CORNER OF WALL.

ft. Slip flanges of special design make connection and disconnection an easy matter. At any joint an elbow could be bolted on and the concrete directed into the forms from that point, allowing the stream to shoot directly to the form or employing a "boot-leg" to spread the concrete in wide forms. The pipe was well tied to the forms at bends, on account of the force of impact of the batches which, traveling at great speed, tend to throw the pipe out of line.

On the dam a derrick, which handled the "plums" used in the wall, shifted the riser pipe from section to section as they were poured, the main pipe being laid on the ground at the foot of the form. Each section was poured in three lifts, the conveyor pipe rising 15, 30 or 37 ft. for the lifts.

The greatest distance the charges were conveyed was 600 ft. This includes a 37-ft. rise from the ground to the top of the forms at about 100 ft. from the mixer, and curves between the mixer and discharge elbow aggregating 400 degrees. The operation at this distance was slower than at a shorter distance on account of the greater volume of air required to discharge, a pause for the air pressure to rise being necessary between shots.

Progress on the wall was necessarily slow, due to the fact that it was poured in alternate sections, averaging about 30 cu. yd. each, which necessitated many form and pipe changes. The average rate on the wall was 100 yd. per shift, which usually filled all available forms. On the dam progress was much faster because of larger sections, the average rate being 250 yd. per day. High rates of pouring were attained, but could not be maintained long owing to lack of material, necessity for changing pipe, or the fact that too much liquid concrete could not be poured into a form at once. On most days the rate of pouring varied from 30 to 50 yd. per hr.

During the time this work was carried on there were days when the temperature was down to zero, but no difficulty was experienced on this account. The water and sand were heated and the operator's platform inclosed. As only a few seconds were required for transit, the concrete went into the forms hot, and in the large masses with heavy forms there was no chance of freezing.—*Engineering News.*

TESTS OF A GAS-ENGINE-DRIVEN AIR COMPRESSOR

We reproduce here, mostly as a matter of record, an abstract, from the Journal of the American Society of Mechanical Engineers, of a report of the Boiler Inspection Society of the Mining District of Dortmund, Germany. It relates to a compressor installation at the Consolidation Mine in Germany.

While gas engines have been used widely to drive electric generators, their use for air compressor operation in Germany appears to have been very small and only in installations of an experimental nature. The present installation, therefore, represents a very bold advance involving a compressor handling per hour 15,000 cbm. (say 530,000 cu. ft.) from atmospheric pressure to a pressure of 6 atmospheres gage. The gas engine is a four stroke cycle twin tandem engine working on coke-oven gas with a heating value of from 4,000 to 4,500 WE, (448 to 504 B.t.u. per cu. ft.). The high pressure and low pressure cylinders of the air compressor are directly connected to each of the sides of the gas engine, each side of the engine being so designed that it can compress as a single stage compressor from 4800 to 7000 cbm. (169,500 to 247,200 cu. ft.) per hour to a pressure of 5 atmospheres, according to whether the high or low pressure cylinders are operated. The arrangement is such that even when the engine is being cleaned, or undergoing repairs, the compressor is still partly running.

Duration of test, hr.	6
Barometer pressure, mm. water	753.75
Temperature of air sucked in, deg. cent./fahr	13.25/55.9
Temperature behind the low pressure cylinder, deg. cent./fahr.	102.8/217.1
Temperature behind intermediate cooler, deg. cent./fahr	31.4/88.6
Temperature behind high pressure cylinder, deg. cent./fahr.	112.8/235.1
Compressed air pressure, atmospheres gage	6.6
Volumetric efficiency of compressor, per cent	87.7
R.p.m.	90.6
Air output of compressor, cbm/cu.ft.	15,277/539,493
Power consumption of compressor, i.h.p.	1479
Indicated output of gas engine	1774
Mechanical efficiency of the plant, per cent	83.4
Low pressure side:	
R.p.m.	73.5
Volumetric efficiency, per cent	49.9
Air output per hour, cbm/cu. ft.	7051.6/249,004
Compressed air pressure, atmospheres gage	5.1
Average temperature of compressed air, deg. cent./fahr	138/280
High pressure side:	
R.p.m.	87.3
Volumetric efficiency, per cent	72.9
Air output per hour, cbm/cu.ft.	4767.2/168,345
Compressed air pressure, atmospheres gage	4.9
Average temperature of compressed air, deg. cent./fahr	138/280

RECORD OF COMPRESSOR TESTS.

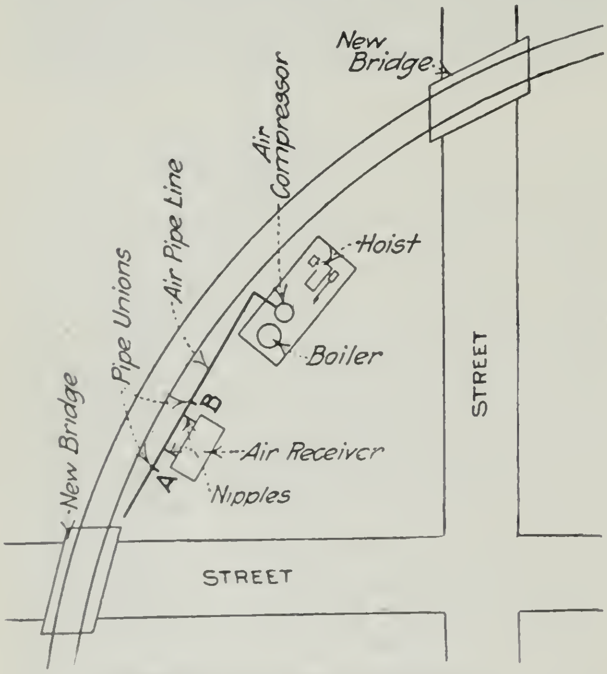
When the engine is operated at its full capacity of 15,000 cbm. per hour it has a speed of 90 r.p.m. The compressor has Horbiger-Rögler plate valves conveniently located in a valve chamber in such a way that they can be easily exchanged. In order to attain as low an air temperature as possible and, further, in order to comply with the police requirement that the temperature in a single stage compressor should not exceed 140 deg. cent. (284 deg. fahr.), the walls of the compressor as well as the compressor piston are water-cooled. The intermediate cooler which permits the cooling down of the partly compressed air to the temperature of suction is placed in the floor in an accessible position. A tube filter of the Blass type is used for cleaning the air in suction.

The engine was subjected to an acceptance test in the period from September 29th to October 4th, 1914, and a further control test on October 13th. The work of the cylinders of the gas engine and compressor were determined by indicating the air pressure and temperature by properly calibrated manometers and thermometers, while the heat content of the gas was determined by analysis and by means of a Junker calorimeter.

In order to eliminate the influence of outside temperature and the action of sun rays on the gasometer, all the tests were carried out after the sun went down. Nevertheless it has been found in testing the air tightness of the gasometer that the pressure lever continued to sink after sundown and this led to the control test on October 13th. The data of the test are shown in Table 1. This test has shown that the plant as it stands did not satisfy entirely the very exacting requirements of the contract but that it was fairly efficient. During the entire test, the engine ran quietly without causing any trouble, and no disturbances of any kind in the operation of the plant were observed.

ROCK DRILLS ARE NOT STEAM ENGINES

The United States Court of Customs Appeals has decided that rock drills and bar hoists are not "steam engines" within the meaning of the tariff law. The collector had classified the articles under the act of 1909 as manufactures of metal, and took duty at the rate of 45 per cent. under paragraph 199. The importers went to the Board of General Appraisers with the claim that the machines fall under paragraph 197, at 30 per cent., as "all steam engines." Presiding Judge Montgomery, in his decision for the court said the real question in the case is whether the articles in the condition as imported come within the meaning of the term "steam engines." He discussed the testimony and concluded as follows: "The attachment which is added to this machine and becomes a part of it as imported was designed for the purpose of adapting it to making it usable as, and only as, a compressed air machine, and only usable by applying compressed air, whereas to constitute it a steam engine a change in the appliance must be made, not only by adding an attachment, but by removing the attachment from the machine as it is imported and substituting another, something which we have no reason to expect will occur or was ever contemplated by the importer or any one dealing with such articles."



SHOWING LOCATION OF RECEIVER.

AIR RECEIVER MAKES TROUBLE IN A RIVETING OUTFIT

A curious case of trouble in a riveting outfit, due to carelessness in arranging and locating the air plant in such a way as to avoid trouble from dust, is described by a correspondent. The work was the erection of several street-crossing railway bridges, where the air plant was laid out to supply several bridges some blocks apart. The riveting gangs were frequently delayed by dust, etc., clogging the ports and valves of the hammers. This was finally traced to two things, the absence of suitable screens at the compressor inlet—the operator thought such a refinement unnecessary in the field—and the unsuitable arrangement of the air receiver. The plant was placed about halfway between two bridges which were some 300 ft. apart. It consisted of boiler, hoist and winch and air compressor, and from here a 1½-in. pipe extended to both bridges. The air receiver was located near one of the bridges. It was cut into a branch or bypass of the line instead of into the main airline itself. Furthermore, on account of the lay of the ground, the main pipe was lower than the receiver, so that there could be no draining down into the receiver, but rather the reverse. As will be seen from the nature of the arrangement, the receiver had no action in the way of removing dust or moisture from the air, and since the railway traffic stirred up a considerable amount of dust alongside the roadbed, the unscreened compressor inlet allowed quantities of dust to get into the system and pass by the receiver to the hammers.

The above, including the title, we reproduce from *Engineering News*, Jan. 28. It is well to thus call attention to the carelessness too frequently shown as to the apparently minor details of compressed air installations. We cannot but think, however, that in this case too much stress is laid upon the mode of connecing the air receiver. As the normal flow of the air did not pass through the receiver, of course none of the dust could have been deposited there; but if the receiver had been so connected that all the air used would have passed through it, only a very minute portion, if any, of the dust in suspension would have been left there.

A cheap and simple air strainer at the intake would have caught the dust before the air entered the compressor, and that would have been the last of it. Such a strainer any one with normal gumption should be able to devise and construct. For instance, make a frame or skeleton of a cubical box, say two feet on the side if for a small compressor, and cover the sides of the frame with or three thicknesses of cheesecloth. Then let the intake pipe get all its air from the interior of this box and the dust will be found on the outside of the box instead of in the pneumatic tools. It would be a profitable refinement to make arrangements for keeping the cheesecloth or burlap wet, and of course it would be necessary to occasionally wash off the accumulated dirt.

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EVERYTHING PNEUMATIC

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AT LEAST DESERVING A FAIR TRIAL

The first article in our present issue should be at least of interest to our readers. It sets forth a scheme which can only be said to be questionable, and being questionable there are two opposite possibilities suggested. It may be practically worthless or it may embody a solution, partial or complete, of a perplexing problem. We are presenting it merely as a matter of general interest in the compressed air field, and without being understood as in any way endorsing the scheme. We are willing, however, to say that trials have been carried far enough for Mr. Brasher to make it appear, as we might say, that there may be something in it. The photos presented are far from convincing. If they had been taken from the beach instead of from an elevation the differences in the condition of the water surface would have been more apparent, and an actual sight of the phenomena exhibited would have been more satisfactory. The confidence exhibited by Mr. Brasher and those associated with him, who are familiar with the developments up to date, is a factor of value in the present situation.

To fairly try this device for robbing the waves of their destructive effect there is perhaps no better opportunity than along the coast of New Jersey, where the losses have been so severe and where they are so certain to continue. The trial mentioned at the Atlantic City pier was absurdly inadequate for the purpose intended, suggesting Mrs. Partington's broom, and, besides that, there are places along the coast which have been more unfortunate and which are more in need of protection. A score or more years ago, perhaps the most attractive popular day steamboat excursion out of New York was that to Long Branch. On account of the uncertainties involved it could only be conducted in a half-hearted way at the best, and now it is among the regretted recollections, because the landing pier could not be maintained. If that pier could have been made secure and permanent, and if the encroachments of the sea along the coast could have been stopped, say by the Brasher system, the cost of compressors and piping would have been absurdly small as compared with the property and business values secured. It would be quite possible to demonstrate at that point, or along the coast line there within a few miles, whether the system would be effective and dependable, but not by a makeshift plant. It can only be decisively determined by an actual trial installation complete in every detail and sufficient if successful to be maintained as a permanency.

AMERICAN INSTITUTE OF MINING ENGINEERS

At the annual meeting of the American Institute of Mining Engineers, listed as the one hundred and tenth meeting of the Institute, at the Engineering Building, New York, Feb. 16th, the following officers were elected:

President, William L. Saunders; Vice Presidents, Sidney J. Jennings and Philip N. Moore; Directors, S. A. Taylor, Robert W. Hunt, Hennen Jennings, George C. Stone and W. H. Aldridge. Secretary and Treasurer are elected by the directors.

The most notable paper presented at the meeting was by Dr. Walter O. Snelling, a research chemist of Pittsburgh, on a process for making gasoline from "synthetic crude oil." B. B. Thayer, President of the Anaconda Copper Company, the retiring President of the Institute, announced a gift of $5,000 from Dr. James Douglas to be used for the extension of the library. Announcement was also made of a gift of $1,000 from Sir Robert Hatfield, to be awarded next year for the best essay by a member of the Institute upon some mining engineering topic.

GUESSING A RIDDLE

A correspondent asks us: What is the approximate production of compressed air in the United States, free air measurement?

As to the answer to this our correspondent knows as much as we do, and compressor builders probably know precisely the same. Nevertheless, here goes:

Say that there are in the U. S. 10,000 compressors averaging 1000 cu. ft. per min. each; the output for a year, 12 hours per day, 300 days would be:

10,000×1000×60×12×300=2,160,000,000,000 cu. ft.

At 2 cents per 1000 cu. ft., which is cheap, this would amount to $43,200,000.00, which total we seriously think is much too low.

This is for bona-fide compressors for compressed air service. Then there are the blast furnaces and foundries whose volume used would be several times as much as this, and the air brake and the beer pumps; and after all there would be the hot air, which is past all computation.

UNDECORATED GENERALS

Gen. Von Kluck and his army made a really impressive march from the Belgian frontier to the gates of Paris, but how much of that victorious march was due to Von Kluck and how much due to some presumably spectacled and narrow-chested individual living in a perpetual atmosphere of tracing paper and calculations in the great gun works at Essen? And when the French, with their terrible "seventy-fives," achieve a victory (i. e., advance a hundred yards or so along part of their line), has not the designer of the "seventy-fives" rather more to do with it than the officer in command? It might not be too much to say that the real winners of modern battles are not soldiers nor sailors, but certain quiet civilians of a studious frame of mind.—*Scientific American.*

SUIT TO RECOVER A FOG

A reduction or abolition of fog as ground for damages in a stream diversion case was recently brought forward in Pennsylvania in a suit against the Johnstown Water Co. The complainant alleged that the building of a dam by the company so reduced the flow in a stream passing by the complainant's land, that prevalence of fog over the land adjacent to the stream was reduced, and in consequence the crops suffered from frosts from which the fog had previously shielded them.

The combination of methods, means and men employed in driving the Rogers Pass Tunnel is keeping up its record breaking, record making pace. The advance of the west pioneer heading, as given in our February issue, was 817 ft. in November and 852 ft. in December, and now comes the figure for January, 932 ft., a bigger jump than before.

A single power transmission line, carrying 140,000 volts, now extends from Bishop Creek to San Bernardino and thence to El Centro, Cal., a total distance of 404 miles.

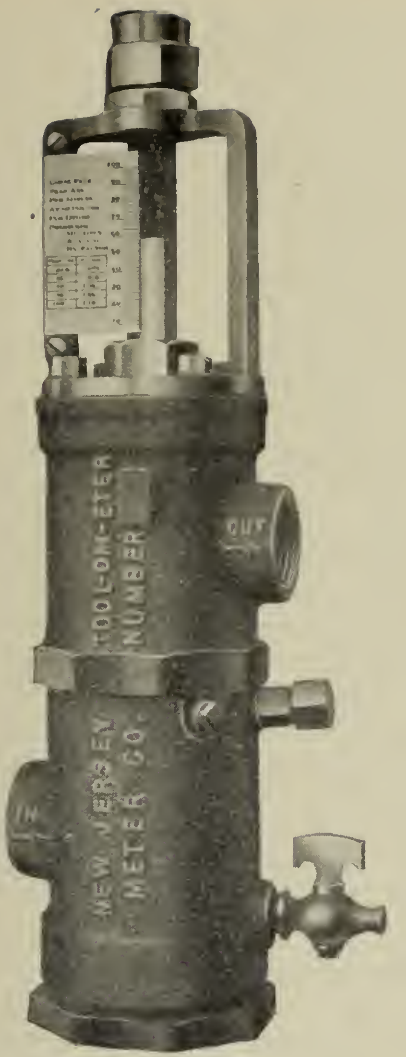

FIG. I.

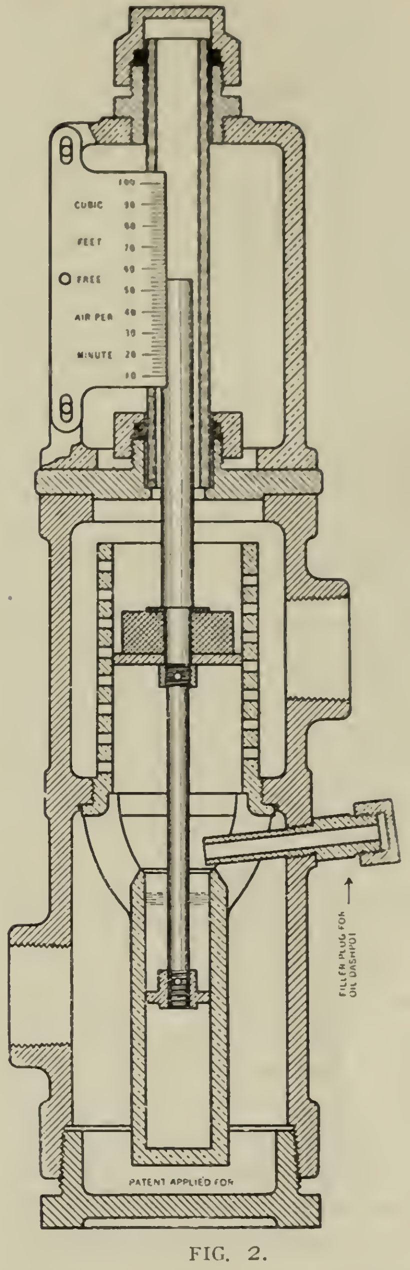

FIG. 2.

THE TOOL-OM-ETER

This is a new device whose use is well suggested by the name which has been invented for it. It is for measuring the air which goes through a pneumatic tool or any air driven device when in operation. Of the "long felt want" of such a device, simple, cheap, handy. and reliable, it is not necessary to speak.

Fig. 1 shows the Tool-om-eter externally and Fig. 2, is a section by referring to which the principle of operation may be easily understood. It is always to be used in a vertical position and is connected to the air supply of the tool whose air consumption is to be measured, the air entering by the large opening near the bottom on the left hand side and escaping through the opening at the right. As the air enters it passes up into the interior of the central cylinder and passes out through the small holes with which this cylinder is perforated and so reaches the discharge opening. The holes are located practically over the entire cylinder surface although unfortunately only those on the section line are indicated in the cut. When the piston is at the bottom of the cylinder no air will be passing through the instrument and the reading at the scale above will be zero. As air begins to pass the piston rises, uncovering successively the holes around the cylinder, the number of holes uncovered varying with the volume of air passing through. This is in accordance with the familiar law deduced by Poncelet: *The volume of a definite compressed fluid or gas flowing under small constant head through multiple orifices of the same shape and size, is directly proportional to the number of orifices exposed to the flow.*

The rod which carries the main piston is continued upward and travels in a glass tube through which it may be seen, the end of it locating the correct reading on the scale at the side. The lower end of the rod carries a piston travelling loosely in a dashpot of oil which steadies the movement. The reading of the scale on the instrument here shown is from 10 to 100 cubic feet of free air per minute, which makes it suitable for most small pneumatic tools, such as chipping and riveting hammers, hammer and air feed drills, wood boring and metal drilling machines, the bosses being threaded for 1 in. pipe. Another size for 2 in. pipe, with scale reading from 50 to 300 cubic feet, is suitable for standard rock drills, coal punchers, sand blast, etc.

If the toolometer is connected into the discharge line of a small compressor its action is of course just the same, and it shows the rate of air compression as accurately as its consumption. As will be seen there is apparently nothing to wear out and certainly nothing to break and from the material used, there is also nothing to corrode. Built by the New Jersey Meter Company, Plainfield, N. J.

A MINUTE STUDY OF ROCK DRILLING SEQUENCES*

BY BENJAMIN F. TILLSON.

Perhaps the consideration of the physical phenomena relating to the process of drilling may prove of interest and value. When rock is excavated by a drill bit three applications of force seem to be involved: by abrasion, by crushing, and by severing or chipping. Although all of these must take place to a certain degree, the greatest amount of useful work is performed when the percentage of force applied to chip reaches a maximum. But in rock it appears that chips can be produced in radically different ways: first, by the severing of molecules, and second, by the reflex forces produced in an elastic medium. To illustrate this, consider the chipping of a comparatively inelastic substance such as lead. With a hammer and a chisel, whose axis is inclined considerably from the normal to the surface of a lead block, it is possible to sever the lead and roll up chips, but if the chisel is normal to the surface of a thick block only an indentation can be made and there probably will be a raised area about the indentation to accommodate a certain percentage of the displaced metal. On the other hand, with a highly elastic material, such as glass, the forces impressed by a normally positioned chisel will cause a compression of the molecules, whose elasticity will cause their expansion toward a free, unresisted surface. Since the greatest forces are developed at the surface, since the penetration of the chisel carries some forces to a depth below the surface; and since the chisel surface itself applies some forces at an angle to its axis and impedes the re-expansion of molecules to the space it occupies, therefore, the reflex forces produce more or less cone-shaped chips or flakes and leave a corresponding crater in the block of glass. Now, if the chisel is placed near the edge of a block of glass, the blow upon it will induce stresses to another free face and a correspondingly larger chip will be produced because of the tendency of the forces to seek relief in the shortest direction as well as because of the severing effect. The method of cutting of a drill bit is commonly shown as taking place in this last way with the progressive chipping of a series of benches or steps, but it is doubtful whether such a procedure exists, except in rare instances, for the speed and latitude of rotation between consecutive blows of the drill piston or hammer cannot be controlled with sufficient precision nor adjusted to the various rocks; and an inspection of the cuttings from a drill hole shows them to be flakes, or a crushed and abraded powder.

In the formation of these flaky chips there may be a limiting force of blow for each velocity of impression in order to gain the most useful work (*i. e.*, in the production of flakes). for it appears that beyond certain limits the blows increase the percentage of crushed material and the drilling speed does not vary with the force applied, so that some heavy-hitting drills accomplish more in medium-soft ground when a portion of their blows are absorbed by a tappet at the shank end of the steel or by a cushion of water intervening between the bit and the rock. If the force of the blows was lessened by a reduction in air pressure the speed of the piston would be slowed up, and the drilling would suffer from the fewer number of blows per minute.

The transmission of the kinetic energy of the piston to the rock is also influenced by many factors. The blow may be delivered against the rock by the free drill steel which is driven forward through the intervening air or water by the impact of the piston and the velocity of the steel will depend upon the relative masses of the drill steel and piston, the velocity of the piston, and the coefficient of elasticity of the steel, in accordance with the well-known laws of mechanics which deal with elastic or partly elastic bodies and their impact. The drill steel in this way assumes the functions of a "jumper" drill which is driven against and rebounds from the rock at a high frequency, and its action is well seen in most all screw-feed hammer drills with the ringing or jingling of the steel in a drill hole. Another mode of force transmission is by compressional waves, traveling through the drill steel from the shank to the bit. This latter condition brings a cutting effect only when one end of the steel is tight against the rock, but then proves very efficient. Although the air-feed hammer drills usually chatter the steel against the rock, like a projectile shot from the chuck bushing by impacts of the piston, yet it seems possible to approximate the other working condition by designing the air feed so that the pressure is lowered as the piston is traveling on its back stroke (possibly by taking the supply air, for the back stroke, from the air feed) and so that the air-feed pressure builds up and forces the drill against the rock just before it is struck by the piston. The reversed-air feeds may sometimes approximate these conditions and then assist the machine to a higher drilling speed. If hammer drills were made so that the drill steels were always held firmly against the rock, when the piston strikes them, it seems unquestionable that the greatest efficiency of the blows of the piston would result, providing they were properly timed, for no energy would be lost by reason of the inertia of the drill steel, but only that due to heating, resulting from the imperfect elasticity of the metal. The question of the proper timing of the piston blows opens another phase of the matter, namely, the reaction of the rock upon the drill steel; and this effect is the more pronounced with harder rock. It tends to speed up the piston and is so noticeable in running a machine against a metal block as to invalidate, as too high, all air-consumption tests so conducted. The effect of these reactive vibrations upon the drill steel may prove very marked and serious. Where the reactive vibrations interfere with oncoming compressional waves, considerable energy is dissipated, and at times one may be so fortunate as to detect points of increased temperature (probable nodes) upon a drill steel which is cutting ground; and it is no uncommon thing to see a drill steel, in service, break at two points (into three pieces) simultaneously, probably from fatigue because of these vibratory stresses. On the other hand, if these vibrations synchronize at the bit it is quite possible that the chipping forces are greatly augmented, and such an explanation may readily answer those puzzling drill tests in which a dull or broken bit exceeds a finely formed bit in drilling speed. For a long time at Franklin a tally was kept of the different individual drill steels which entered into the testing, with the hope of determining that some particular piece of steel produced the greatest cutting speed, but no conclusion could be drawn from the records, except that the changes in length due to resharpening probably masked any possibility of determining the suitable lengths for maximum efficiency. And it seems quite plausible that such a result should be expected if the possible wave lengths of the compressional vibrations in the drill steels are considered. Probably these reactive vibrations occur to a great extent, as well, in the process of drilling, where the steel dances in the chuck and against the rock, for steel breakage appears equally as high, if not higher, with such a type of machine as with the pneumatic feed, and tests comparing these two types for such effects might prove very interesting as well as instructive.

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*Extract from paper before the American Institute of Mining Engineers, Feb., 1915.

But still other factors influence the force delivered at the rock. If the anvil block or tappet is not in contact with the drill when the piston strikes, a considerable energy loss occurs through the transference of momentum to several pieces. If the steel is bound in the chuck bushing, a great amount of the energy is absorbed by the friction. If the steel is not straight, it loses energy because of the flexure. If the chuck is badly worn, the axis of the steel does not coincide with that of the drill and there is a loss due to the oblique, eccentric impact. If the steel is tight in the drill hole, or if the friction against the side of the hole is great because of its depth, the velocity of the steel, as a projected body, is lessened and the drilling speed is reduced.

The length of the drill steel is an item generally credited as an important influence, and common opinion supports the idea that the cutting speed falls as the length of the steel increases, although some people, on the contrary, feel sure that the long steels drill the fastest. The tests conducted at Franklin do not lend an unqualified support to either view, for the peculiarities of different types of machines play so important a part. For example if the air feed is very strong in a stoping drill the additional counteracting weight of a long and heavy steel may so improve the working conditions as to indicate a superiority for the long steel, and if the air feed is weak the reverse may be true; if the drill steel cuts by virtue of a dancing or "jumper" action, the mass added with length may so reduce its velocity against the rock as to bring it below the amount required for efficient chipping; if the piston normally delivers too heavy a blow for the rock, the drilling speed may be improved by the added inertia of the long steel; and if the steel is always against the rock when a blow is delivered, it is doubtful whether the length of the steel plays an important part unless the permitted decrease in the gauge of the drill bits aids the cutting speeds. It is, of course, to be understood that the above considerations of drill-steel lengths refer to the performances with bit gauges of the same diameter.

The use of an anvil block is considered by some drill designers to necessitate a loss of from 20 to 30 per cent. of the power of a drill but actual tests do not always indicate such a condition when the identical steel is tested in the same drill with and without a tappet. The results probably depend upon how frequently the tappet is struck when away from the shank of the steel, and also upon the suitability of the machine to the rock, for if its blows are too heavy the intervention of a loose tappet might reduce their force, with a benefit in drilling speed. The use of water at the bottom of the hole ordinarily consumes about 10 per cent. of the cutting speed if there is no tendency for the drill bits to lose their temper, and compressed air for cleaning the holes encourages a greater drilling speed, providing the cushion of water in the bottom of the hole does not have a benign influence in reducing too powerful a blow upon the rock.

The manner in which a drill is rotated has a bearing upon the amount of work accomplished, and with hand-rotated tools, a vigorous rotation with a rapid and wide arc of swing produces the best results; with power-rotated drills it is possible to reach such a speed as to abrade and dull the drill bits, and consequently lessen the drilling speed. It seemed that, with a positive and constant rotation, the axial planes of the cutting edges of the drill bits should be at the same angle with the cut surface as the resultant velocity vector, as estimated for the rotative and striking velocities; and such a bit was tried at Franklin without showing a change in cutting speed, probably because with either bit the chips came out in flakes, as previously described.

NOTES

Manufacturers of valves, cylinders, recording gages, filling and weighing stands, and of materials and appliances entering into the manufacture, transportation and sale of compressed gases, are requested to send catalogues, price lists and full descriptive details to the Secretary of the Compressed Gas Manufacturers' Association, Inc., 25 Madison Avenue, New York City.

An illustration of the danger of gas being ignited by incandescent lamps used for lighting the drilling rigs of gas wells is given in a recent field report of J. J. Rutledge, mining engineer of the Bureau of Mines. The driller on duty at the time of the fire declared that a pebble blown from the well struck and broke an incandescent lamp bulb, so that the gas from the well was ignited by coming in contact with the broken filament. The resulting fire totally destroyed the rig and caused considerable additional damage.

The most northern railroad in the world is to be strictly an electric one. It is located near Porjus Falls, in Lapland, one of the largest in that northern peninsula. The building of the power plant was a government project, costing about $5,000,000. The economic justification of this outlay is that the new Lapland railway is expected to bring ore from the great Arctic iron mines.

This may sound like a joke, but it is not. A certain zinc smelter reports that he is now getting everything out of his ore but the "squeal." Asked to explain what he meant, he said that he is now putting up in barrels the residuum from his retorts and selling it as a specific against hog colera. There is active demand for the substance for that purpose. It is said that the zinc residuum spread over the hog yard stamps out the germs of hog cholera and the hogs experience no further trouble. Nobody offers any explanation. This is simply reported as a thing that is so.—*Eng. and Min. Journal.*

Experiments have been conducted in Austria on the maturing or aging of wines by refrigeration and aeration. New wines in bottles and casks were first subjected to a temperature of 28.4 to 26.6 deg. Fahr. (at which temperatures they did not freeze) for a period of from 24 to 48 hours, after which they were aerated by passing air through them for 24 hours or racking them off and allowing them to fall in a shower through air. While red wines showed no effects from the treatment, in white wines the color was darker and the taste and fragrance had decidedly more the character of old and ripe wines than in the untreated samples. There was found to be a marked decrease in the content of nitrogenous matter; i. e., the same effect as that ordinarily produced in wine by keeping it a long time in cellerage and racking it repeatedly.

Not long ago an inquisitive field mouse shut down more than half the mines and mills of the Porcupine gold camp of Ontario and interrupted the production of gold for half a day. The mouse got into a switch on the transformer house at the Jupiter mine and made a short circuit. A generator was burned out at the Sandy Falls power plant and the mishcief was done. The Hollinger and all other companies using the Sandy Falls power were without power for half a day. No mouse can do the trick more than once.

When the United States revenue cutter Seminole was being overhauled at Arundel Cove, Md., recently, it was found that the ship's old boilers would have to be removed and new ones substituted in their place. These had originally been set while the vessel was in the course of construction, and to lift them out bodily it would have been necessary to tear out a large section of the upper deck. As it was, the work was accomplished quickly by cutting the boilers into strips with oxyacetylene torches. Two men, each with a torch, cut through approximately 1000 ft. of steel plate, averaging 1 in. in thickness, in 30 working hours.

To save Pringle Hill and Courtdale, two mining villages on the west bank of the Susquehanna River, in Pennsylvania, from dropping into the mines, the Kingston Coal Company has begun operations that may result in the flushing of Pringle Mountain into worked-out veins. Stone crushers and steam shovels are being installed for this latest innovation in mining.

A number of plants in St. Louis, Mo., are producing commercial oxygen electrolytically. A 10 to 15 per cent. solution of caustic soda or caustic potash is employed. Through this a current of electricity is passed and the oxygen that collects at one electrode is trapped and led off to a compressor, while the hydrogen is permitted to escape.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 5.

1,123,311. AIR-MOTOR. Justus R. Kinney, Boston, Mass.

1,123,327. COMPRESSOR. Charles H. Leinert, Chicago, Ill.

1,123,335. PNEUMATIC GRAIN-ELEVATOR. Henry G. Lykken, Grand Forks, N. D.

1,123,372. DRILL-SHARPENER. Theodore Hiram Proske, Denver,, Colo.

1,123,426. PNEUMATIC CLEANING APPARATUS. Albert E. Tolin, Anderson, Ind.

1,123,498. BOAT PROPULSION. Rex Dean, Findlay, Ohio.

1. An apparatus of the class described, comprising a vessel, a Venturi tube carried thereby, a pipe ring surrounding the restricted portion of said tube and provided with orifices leading to and communicating with the interior of said tube, said orifices curved and pointing in a rearward direction, and a pipe communicating with said pipe ring adapted to supply a gaseous medium thereto under pressure for the forcible projection of a liquid medium through said Venturi tube in a rearward direction, resulting in the forward propulsion of the boat.

1,123,527. ROTARY FLUID-PRESSURE MOTOR. Henry J. Hanzlik, Trenton, N. J.

1,123,542. PROCESS OF AGITATING AND AERATING SUBSTANCES. Werner Jansch, Charlottenburg, Germany.

1,123,588. APPARATUS FOR LIQUEFYING AND SEPARATING ATMOSPHERIC AIR. James F. Place, Glen Ridge, N. J.

1,123,627. PNEUMATIC PLAYER. Eugene T. Turney, New York, N. Y.

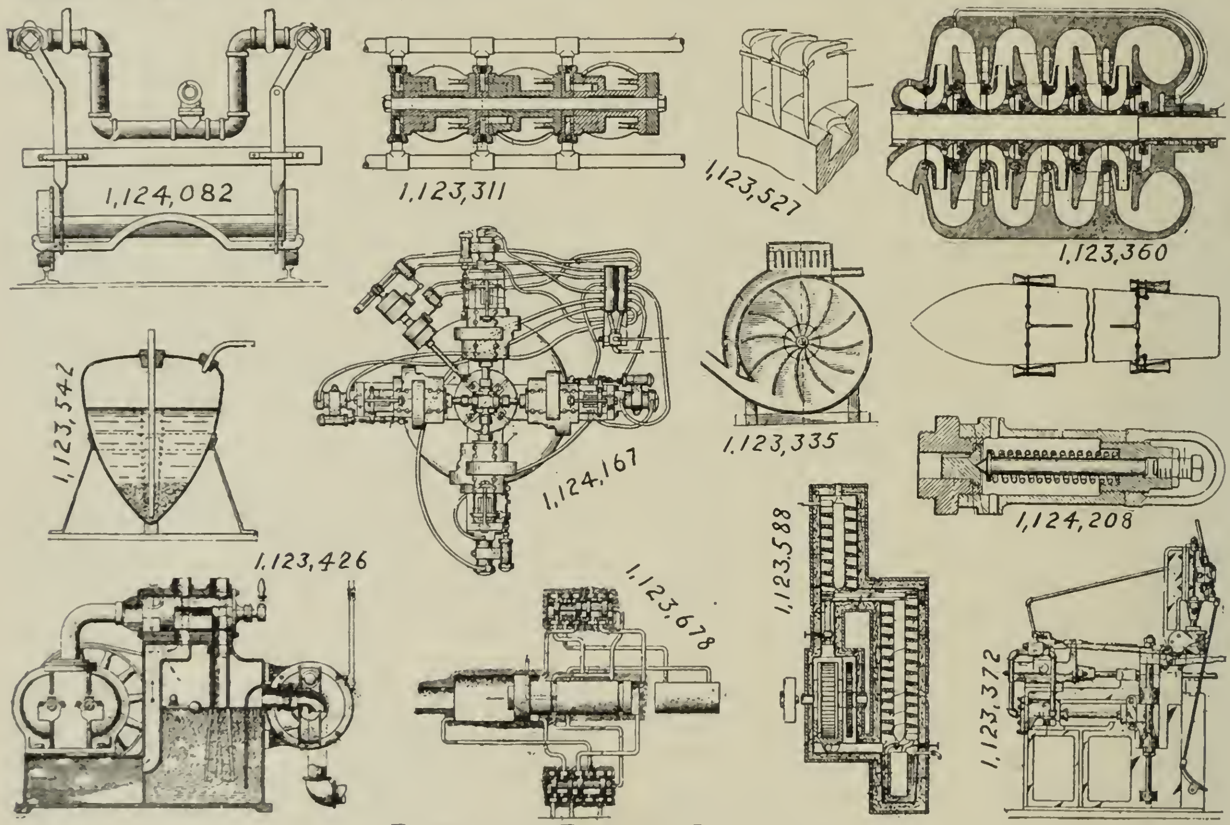
1,123,678. PNEUMATIC IMPACT-TOOL. William Burlingham, Newport News, Va.

1,123,684. GLASS-DRAWING APPARATUS. William L. Clause, Pittsburgh, Pa.

1,123,728. DRY SEPARATOR AND CONCENTRATOR. Fritz Henry Gordon, Portland, Oreg.

1. The combination with a separator comprising a frame, a shaker having a plurality of screen openings mounted to vibrate therein, a body portion adapted to receive air under pressure fixed beneath the screen openings, a receptacle in the body portion beneath each screen, and an air chamber at the rear of each receptacle leading from the body portion to the screened opening, of a forwardly inclined deflector in the shaker at the rear of each chamber and a forwardly closing valve at the outlet of each chamber.

1,124,082. AUTOMATIC BRAKE-SETTING MECHANISM FOR PNEUMATIC BRAKES. Robert J. Weldon, Fort Worth, Tex.



Pneumatic Patents January 5.

1,124,167. PNEUMATICALLY - CONTROLLED MULTIPLE - SPINDLE TAPPING AND DRILLING APPARATUS. Rae W. Phillips, Los Angeles, Cal.

1,124,200-1-2. AIR-BRAKE APPARATUS. Henry F. Bickel, Plainfield, N. J.

1,124,203. SAFETY-VALVE FOR AIR-BRAKE APPARATUS. John W. Bingley, Watertown, N. Y.

JANUARY 12.

1,124,255. CONTROL FOR PNEUMATIC-DESPATCH APPARATUS. Robert Ball, Philadelphia, Pa.

1,124,285. DEVICE FOR WITHDRAWING BLOOD FROM THE BODY. Philip V. Brown New York, N. Y.

1,124,304. PROCESS OF PRODUCING OXYGEN. Paul Danckwardt, near Dardanelle, Ark.

1. The process of producing oxygen, which consists in heating a mixture containing alkali metal manganate or substances that will form this by heat, and one or more other substances forming a diluent, until the mass is fluid, introducing under pressure into this mass air and steam in such a way that the gases cannot mingle with each other, the pressure of the gases being materially greater than that due to the resistance of the molten mass, and collecting the gases separately.

1,124,407. APPARATUS FOR TREATING ROADWAYS. Sam Everett Finley, Atlanta, Ga.

1. Apparatus for treating roadways with oil or the like, comprising a tank, multiple spray nozzles delivering rotary conical sprays to the road surface, a pump for delivering the material under pressure from the tank to said nozzles, and means to direct a blast of air on the roadway in advance of said rotary conical sprays.

1,124,409. ROTARY FLUID-PRESSURE MOTOR. Francis M. Floyd, Elkville, Ill.

1,124,460. AIR-MOTOR. Gyula Koesis, St. Clairsville, Ohio, and John Luko, Latrobe, Pa.

1,124,505. PNEUMATIC - DESPATCH - TUBE APPARATUS. John T. Needham, Bayonne, N. J.

1,124,539. PNEUMATIC STACKER. Joseph K. Sharpe, Jr., Indianapolis, Ind.

1,124,573. COMBINED VACUUM-CLEANER AND BLOWER. Ernest L. B. Zimmer, Oakland, Cal.

1,124,575. AIR CONTROL AND SIGHT ATTACHMENT FOR VACUUM - CLEANER TOOLS. Ernest L. B. Zimmer, Oakland, Cal.

1,124,600-1. METHOD OF RAISING AND PURIFYING WATER. William S. Franklin, South Bethlehem, Pa.

The method of purifying water consisting in causing ozonized air to pass through and lift a body of water, the ozonized air being under a constantly decreasing pressure throughout the entire time of contact.

1,124,684. PNEUMATIC CLEANER. George W. Allen, Boston, Mass.

1,124,830. SAND - RECLAIMER. Harry L. Allen, Alliance, Ohio.

1. In a sand reclaimer, the combination of a pair of casings one within the other in spaced relation, perforated deflectors within said inner casing, said casing being provided with a plurality of openings at points beneath each of said deflectors, said openings providing communica-

tion with the spaces between said casings, means for partially exhausting the air within said casings and thereby removing dust from the sand, and means for admitting atmospheric air to said inner casing, substantially as described.

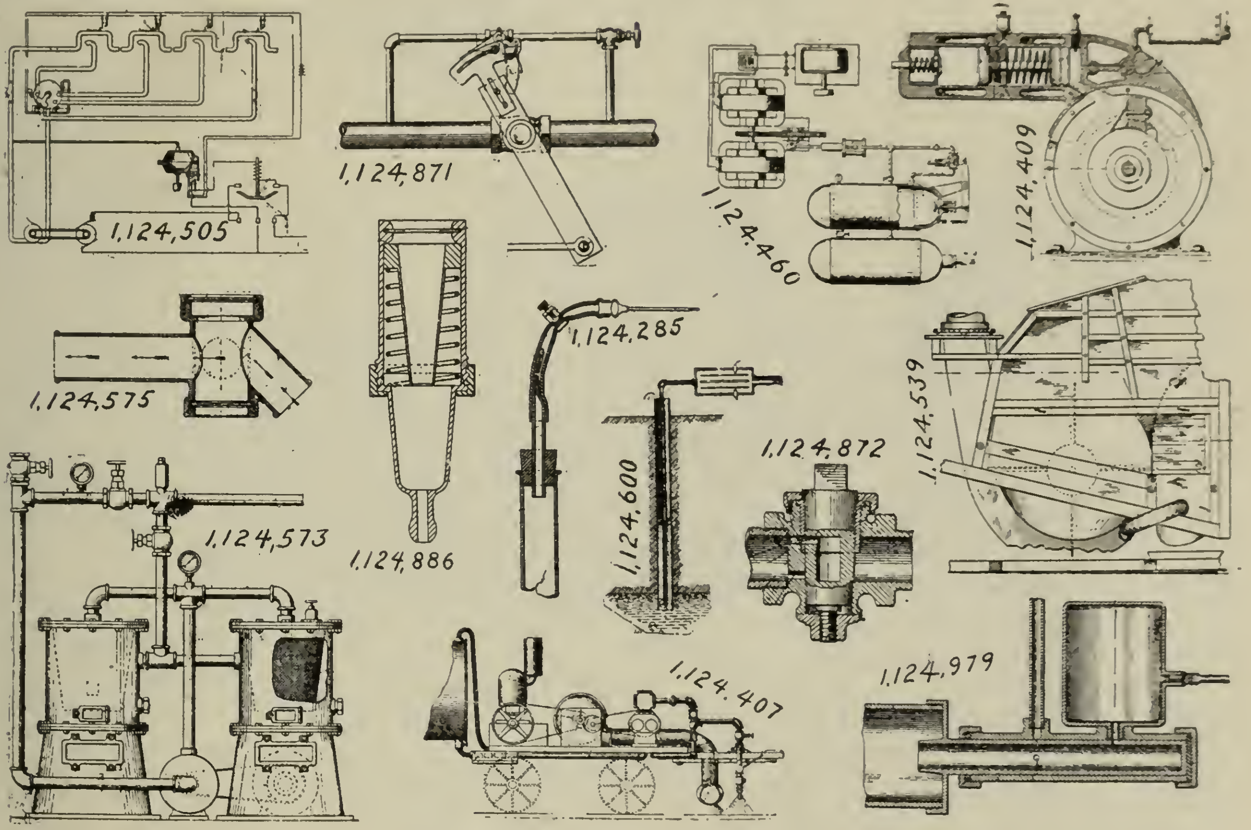
1,124,871. FLUID - PRESSURE - CONTROLLING MECHANISM FOR GLASS-DRAWING MACHINES. Charles Day, Arnold, Pa.

1,124,872. AIR-VALVE FOR GLASS-DRAWING MACHINES. Charles Day, Arnold, Pa.

1,124,886. PNEUMATICALLY - OPERATED TEAT-CUP. Alexander Gillies, Heidelberg, and Harold Bartram, Melbourne, Victoria, Australia.

1,124,979. VAPORIZING APPARATUS. Charles Alfred Waldeck, Baltimore, Md.

1. In a vaporizing apparatus, a rotary cylinder, a stationary sleeve, means for admitting compressed air and chemicals to the said sleeve, a hollow journal on one end of the cylinder and extended into the sleeve, means for providing a water-tight joint between the sleeve and the hollow journal, and means for controlling the feed of chemicals to the cylinder.



Pneumatic Patents January 12.

1,124,997. VACUUM OR SUCTION SWEEPER. Homer L. Boyle, Lansing, Mich.

JANUARY 19.

1,125,118. COMPOUND BLOWER. Charles Volney Kerr, Wellsville, N. Y.

1,125,135. LUBRICATING DEVICE. Brace Leland, Winona, Minn.

1. In a device of the character described, in combination, a casing adapted to contain lubricating fluid, a source of compressed air, an outlet pipe leading from said casing, and a filling inlet pipe surrounding the outlet pipe and connected with the compressed air supply.

1,125,151. AIR-RETAINING VALVE FOR AIR-BRAKE APPARATUS. Spencer G. Neal, Los Angeles, Cal.

1,125,214. BRAKE - PIPE VENT - VALVE. Walter V. Turner and Patrick H. Donovan, Edgewood, Pa.

1,125,215. EMPTY AND LOAD BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,125,348. APPARATUS FOR PULSATING OR VARYING AIR OR FLUID PRESSURE. William Henry Lawrence, Melbourne, Victoria, Australia.

1,125,413. PNEUMATIC APPARATUS FOR TRANSFERRING MATERIAL. Chester J. Van Doren, Chanute, Kans.

1,125,480. MINE-DRILL SUPPORT. Howard P. Corsa, Bingham Canyon, Utah.

1,125,559. BLOWPIPE. Aage Kofod, Zurich, Switzerland.

1,125,593. FLUID POWER-TRANSMITTER. Thomas D. W. Pinckney, New York, N. Y.

1,125,684-5. AIR-CIRCULATING DEVICE. Louis Greenberg and Gustaf Olson, Chicago, Ill.

1,125,722. FLUID - PRESSURE ENGINE. James Dennis Roots, London, England.

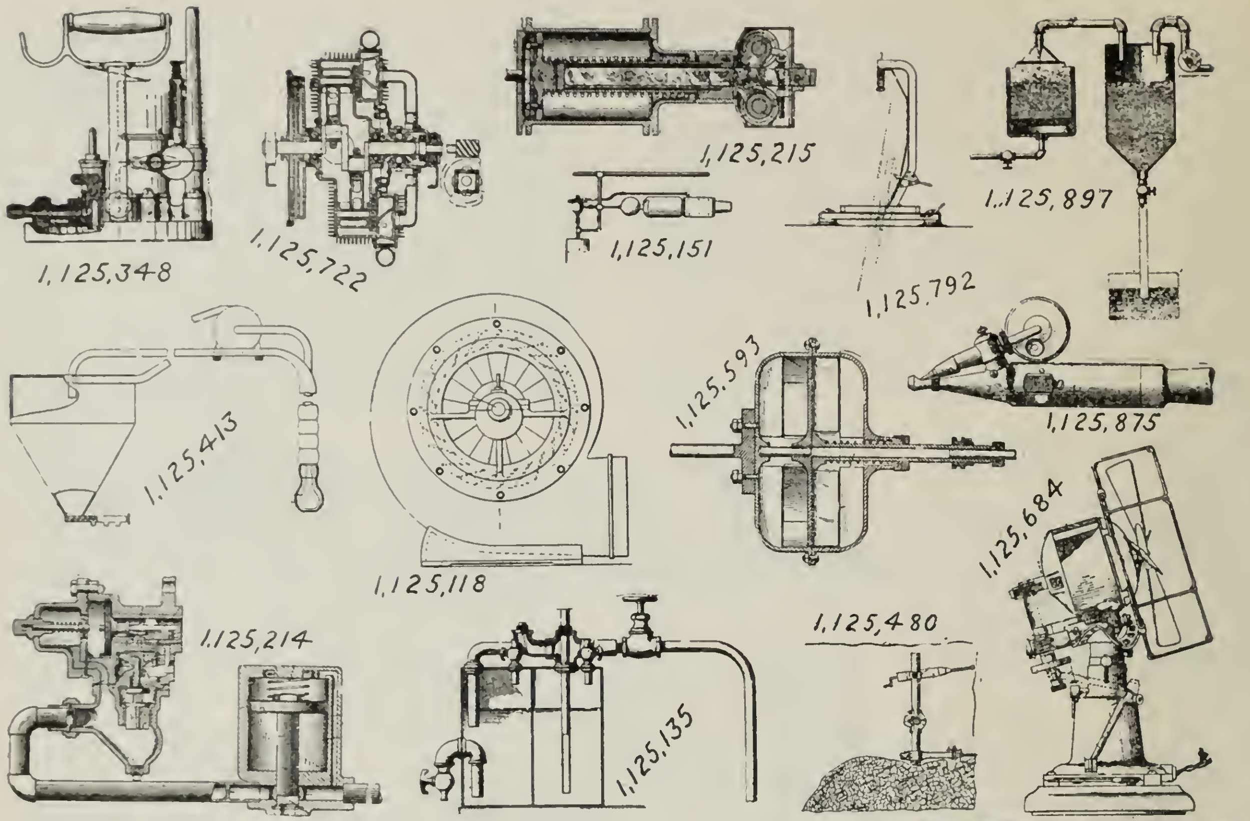
1,125,752. VACUUM LIFTING-MACHINE. Carlton L. Smith, Saginaw, Mich.

1,125,875. AIR-BRUSH. Jens A. Paasche, Chicago, Ill.

1,125,897. PROCESS OF CONCENTRATING ORES. John M. Callow, Salt Lake City, Utah.

1. The process herein described of breaking down and discharging the froth, foam or sud, accumulating on the surface of an aerated and agitated mineral-bearing pulp containing a frothable agent having a selective affinity for metalliferous particles, said process consisting, essentially, in producing in a vessel open to the atmosphere a difference in pressures between the inside and outside of the air bubbles forming the froth, foam or sud, and conducting the fluid contents of the broken down bubbles and mineral particles thereof to a receiver.

1,125,900. OZONATOR. Arthur R. Darling, Indianapolis, Ind.



Pneumatic Patents January 19.

JANUARY 26.

1,125,930. BARREL-CLEANING APPARATUS. Heinrich Wilhelm Arnemann, Hamburg, Germany.

1,126.004. COOLER FOR ROTARY COMPRESSORS. Willibald Grun, Frankfort-on-the-Main, Germany.

1,126,011. AIR-HEATER. Richard L. Hubbard, Astoria, N. Y.

1,126,041. AIR-PUMP STARTER. Carl E. L. Lipman, Beloit, Wis.

1,126,096. PNEUMATIC HAMMER. William F. Schmidt, St. Louis, Mo.

1,126,130. BARREL-PITCHING MACHINE. Harry Torchiani, Chicago, Ill.

1,126,233. VACUUM-GAGE. Irving Langmuir, Schenectady, N. Y.

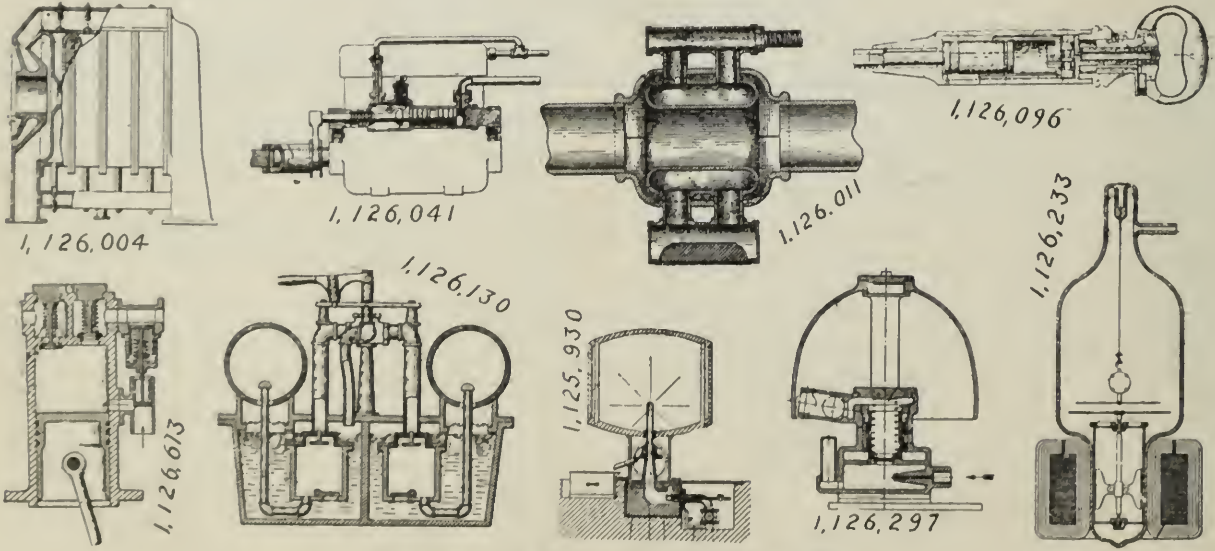
1,126,297. FLUID - PRESSURE - OPERATED ALARM DEVICE. Harry E. W. Sauveur, Boxhagen-Berlin, Germany.

1,126,300. CENTRIFUGAL PUMP, BLOWER, COMPRESSOR, AND THE LIKE. Emil Schneider, Hamburg, Germany.

1,126,371. PROCESS OF PURIFYING HYDROGEN GAS. Carl Bosch and Wilhelm Wild, Ludwigshafen-on-the-Rhine, Germany.

1. The process of producing pure hydrogen consisting in heating hydrogen containing small quantities of carbon monoxid under a pressure exceeding five atmospheres with a solution of caustic alkali.

1,126,613. AIR-PUMP. George Brandstetter, Hohenstadt, and Richard Freund, Vienna, Austria-Hungary.



Pneumatic Patents January 26.

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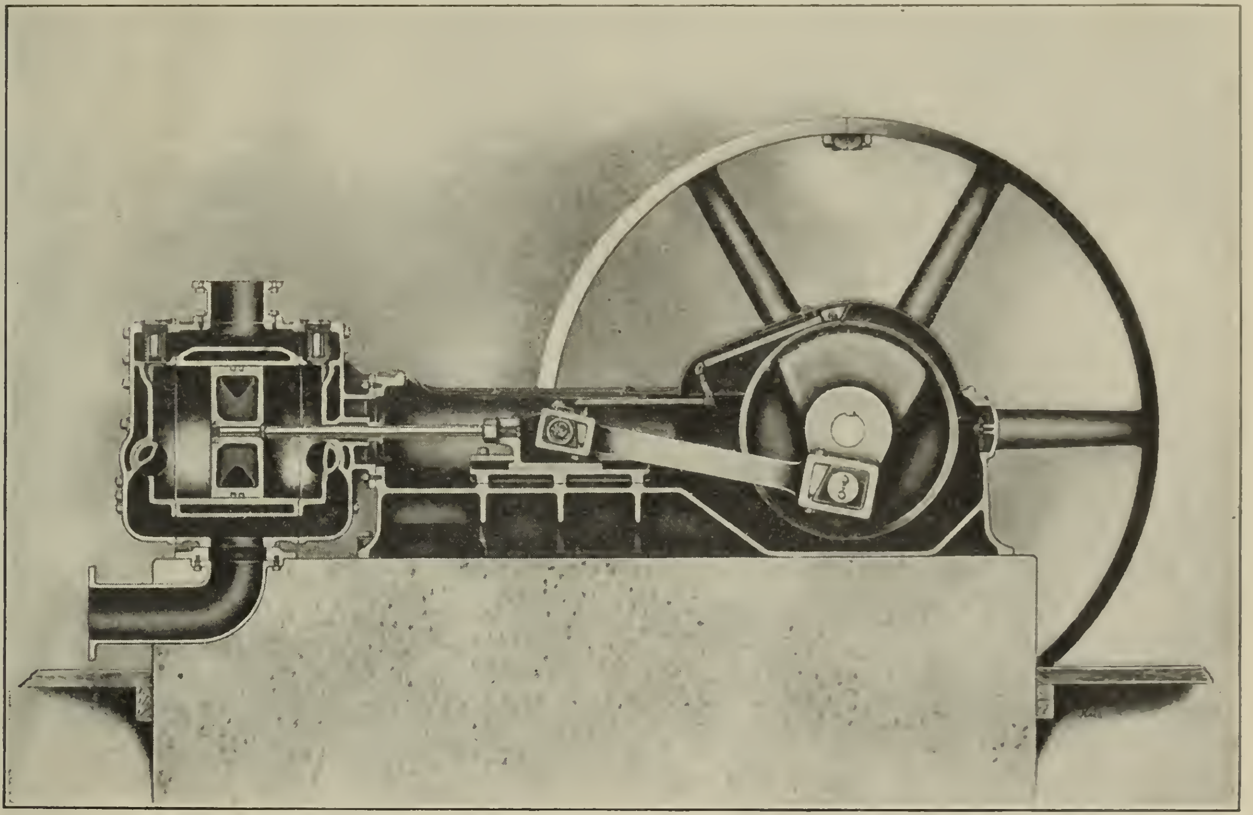


AIR COMPRESSOR FOR VACUUM SERVICE.

AIR COMPRESSORS AS VACUUM PUMPS

BY FRANK RICHARDS.

There are now in established employment in various lines of manufacture automatic and other machines which require a considerable vacuum for their operation. There is also extensive use of high vacua in distillation and evaporation processes, such as occur in the manufacture of sugar, glucose, malt extracts, glue, etc., so that there is an established and permanent demand for machines of large capacity for the removal of air at pressures far below the normal atmospheric.

Vacuum pumps have generally been regarded as more or less special machines, and also they have usually been of capacities much below the modern demands here spoken of. The operation of producing vacua by mechanical means is strictly an act of air compression, and it should be legitimate employment for the standard air compressor.

Until we come to a perfect vacuum, which is not at all contemplated in the present article, the actual so-called vacuum with which we are more familiar is simply air at a reduced or attenuated pressure, and we have only to remove some more of this low pressure air and to expel and deliver it at the actual pressure of the surrounding atmosphere.

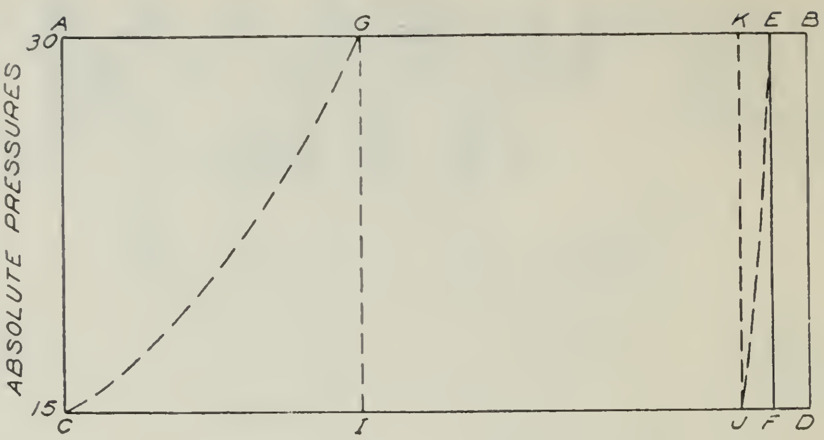


FIG. I. CLEARANCE IN AIR COMPRESSION.

In practice, however, if we take an ordinary air compressor for this work we soon find that there are some details of construction and operation which are imperative for such service, but which are quite negligible for normal atmospheric intake and high pressure delivery.

In the mechanical compression of air, whether the air have a pressure measured by a column of mercury 30 in. high, ordinary sea level atmospheric pressure, or by only 1 in. of mercury, which latter may be said to be near the limit of practical mechanical air pumping in large volume and at a speed not unprofitable; in either case the cylinder can only be filled by some surplus of pressure outside the cylinder to force the air in to follow the piston, so that it is absolutely impossible to produce a perfect vacuum in this way.

It is evident that if the air while being driven in by the air behind it to fill the cylinder, has also in the act of entering the cylinder some work to do, such as overcoming the inerita of a poppet valve to open it and the opposition of the spring which normally holds the valve in the closed position, this also must interfere very much with any possible approach to a perfect vacuum. If instead of poppet valves, to be opened by the pressure of the entering air, there is a mechanically moved inlet valve which is opened at the beginning of the intake and held wide open for practically the whole stroke, this must materially reduce the requirement of pressure excess outside the compressor, and make a more attenuated vacuum possible. It is a fortunate thing that there is a type of compressor equipped with intake valves—Corliss valves—which satisfy the conditions above indicated, and it is a natural consequence that these compressors—as will appear later—give highly satisfactory results in vacuum pumping.

The second essential condition required for successful vacuum pumping by an air compressor is that cylinder clearance shall be as small as possible. In operation it is necessary not only that the air shall be taken into the cylinder for compression but also that as much of it as possible shall be expelled after the compression. Some clearance seems to be absolutely unavoidable, but the air remaining in the clearance space re-expands upon the return stroke, and the new air taken in for the next stroke is only the difference between the volumn occupied by this re-expanded air and the volumn which would constitute a whole cylinderful.

The different effect of cylinder clearance when taking in atmospheric air or when pumping from a high vacuum should be clearly understood by comparing Figs. 1 and 2. In Fig. 1 the area ABDC represents the entire volumn of an air cylinder, including the clearance EBDF, this clearance being 5 per cent of the entire volume. The compression is assumed to be from atmospheric pressure, 15 lbs. per sq. in., absolute, to a pressure of 2 atmospheres, 30 lb. absolute, or 15 lb. gage. GC is the adia-

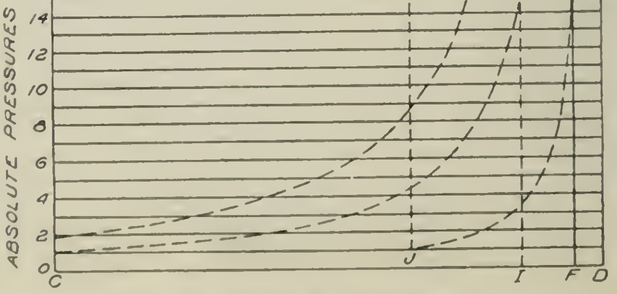
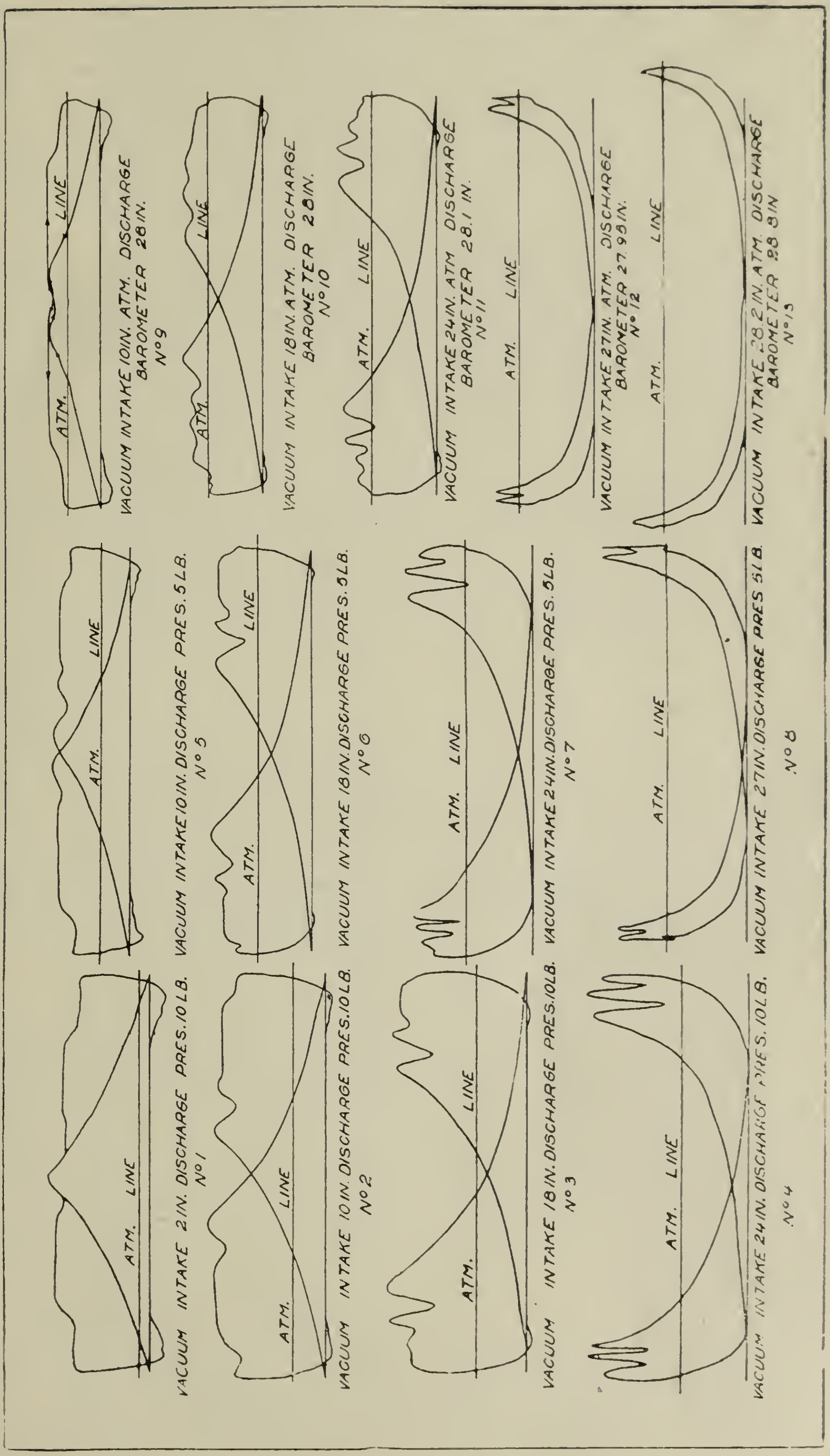


FIG. 2. VACUUM CLEARANCE.



SERIES OF INDICATOR CORDS IN STUDY OF VACUUM PUMPING.

batic compression line, GBDI will be the volume after compression and GEFI will be the volume delivered, leaving the volume EBDF in the clearance space. Upon the return of the piston, EJ will be the re-expansion line, and the volume of fresh air to be taken in for the next stroke will be AKJC, or more than 90 per cent.—it is not necessary to figure minutely—of the full capacity.

In Fig. 2 the cylinder volume and the clearance are the same as before, but the compression on line G is from an absolute pressure of 1 lb. to atmospheric pressure, or 15 lb. absolute. Here EJ will be the line of adiabatic re-expansion for the air in the clearance space and the area AKJC, 65 per cent. of the whole volume, all which can possibly be got into the cylinder for the next stroke. In practice the actual showing would not be as good as this in consequence of the inertia and friction of the air, but the effect of the clearance is sufficiently suggested.

It should be scarcely worth while to call attention to the necessity of having tight valves, inlet and discharge, in a compressor for this service. Also it is to be noted that when working to a high vacuum the ratio of compression is very high, approaching an infinite value as the vacuum produced comes near to the local barometer reading, which large ratio results in high temperatures and in order to attain a reasonable compression efficiency, as well as to secure proper lubrication, the cylinder of an air compressor for vacuum pumping should be thoroughly water jacketed.

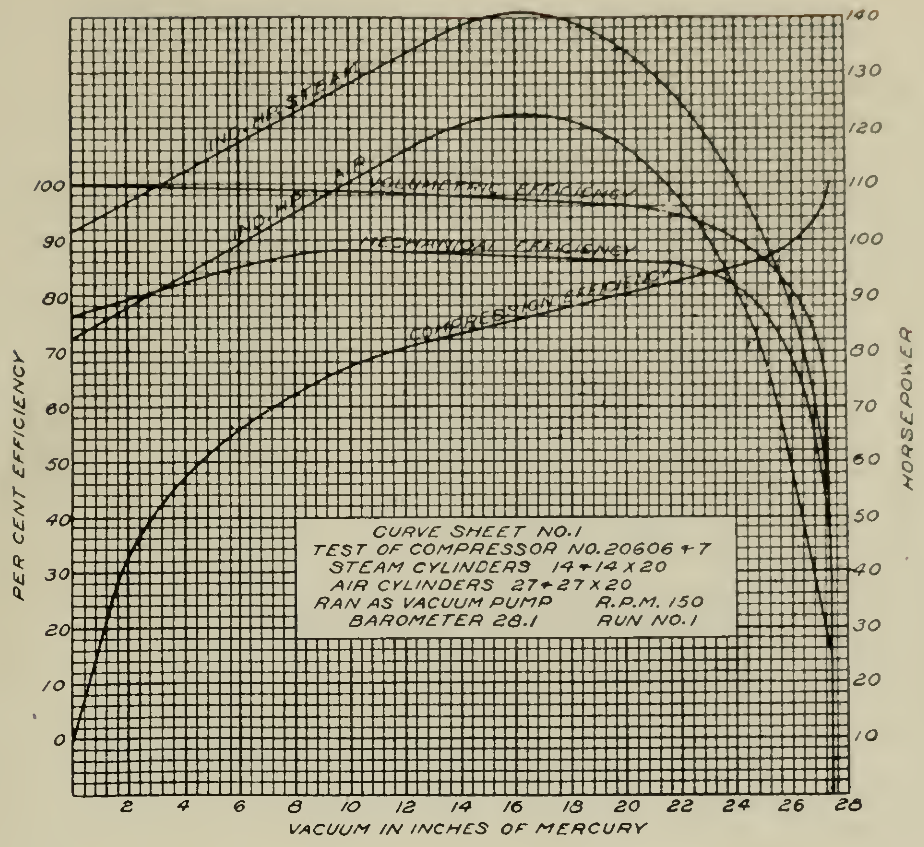
Following this setting forth of the compressor requirements for high vacuum pumping I take pleasure in presenting an interesting series of indicator cards from a compressor in actual service upon a business basis, which cards mostly tell their own story.

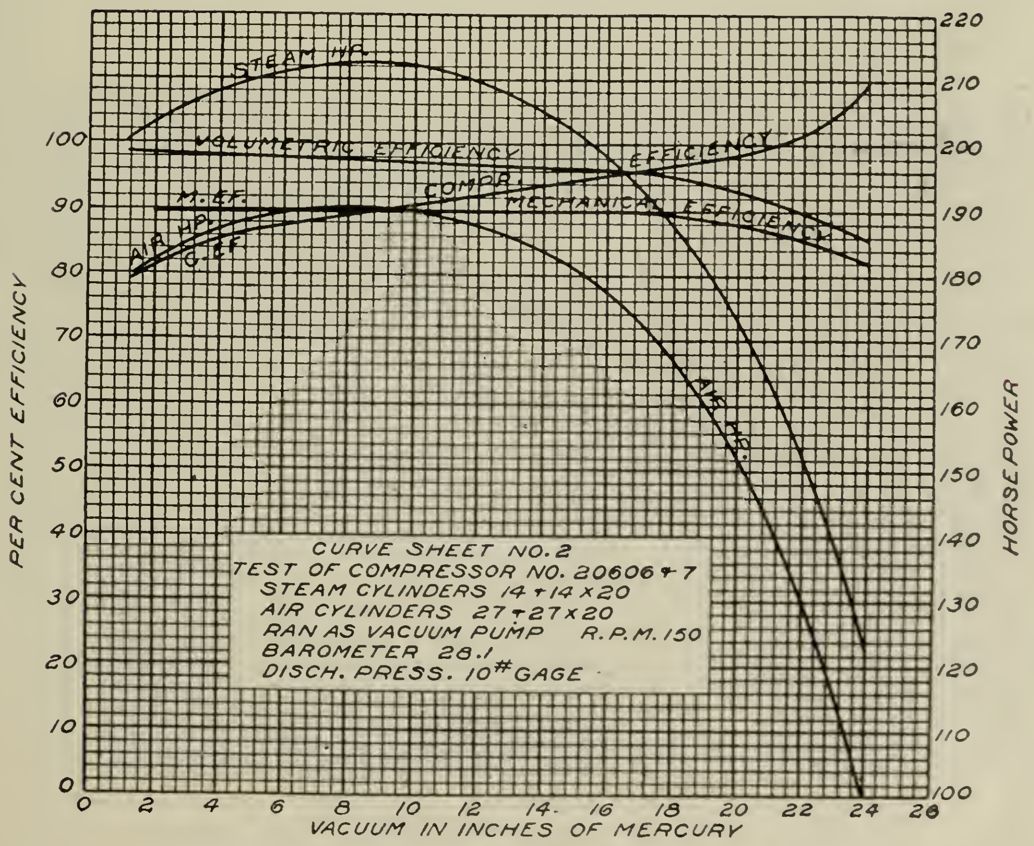
The compressor from which these cards were taken is in constant service at the plant of the Diamond Alkali Company, Fair Port Harbor, Ohio. It is an Imperial Type 10 compressor of the Ingersoll-Rand Company. The machine is of standard duplex construction except that the vacuum cylinders are of abnormally large diameter, 27 in., and the steam cylinders 14 in., with a common stroke of 20 in. It is used exclusively for vacuum pumping and from actual test is capable of maintaining, when exhausting a large receiver, a vacuum within 0.9 in. of barometer. If the intake had been blanked off short at the compressor the vacuum produced would have exceeded this, as minute, undiscoverable leaks are almost unavoidable. This very complete series of cards is valuable as showing the work under different conditions, and especially the influence of the clearance when high vacua are reached. The curve sheets 1, 2 and 3 give a comprehensive idea of the general performance of the compressor at all possible intake and discharge conditions.

A still more interesting installation is that at the plant of the Thatcher Manufacturing Company, Elmira, N. Y. This is an Imperial Type 10, short belt drive compressor, having duplex air cylinders 18 in. diameter, 14 in. stroke, operating at 185 r.p.m. One cylinder takes in free air and delivers it to a receiver at about 20 lb. gage; the other cylinder being used as a vacuum pump, exhausting a receiver to about 19 in. vacuum and discharging to the atmosphere. This combination of compressor and vacuum pump has numerous advantages over the customary dual machine installation in cases where an air pressure as well as a vacuum is wanted. This combination compressor and vacuum pump is used for operating three Owens Bottle Making Machines, the vacuum produced being used to draw the glass into the molds, the pressure then blowing the bottles.

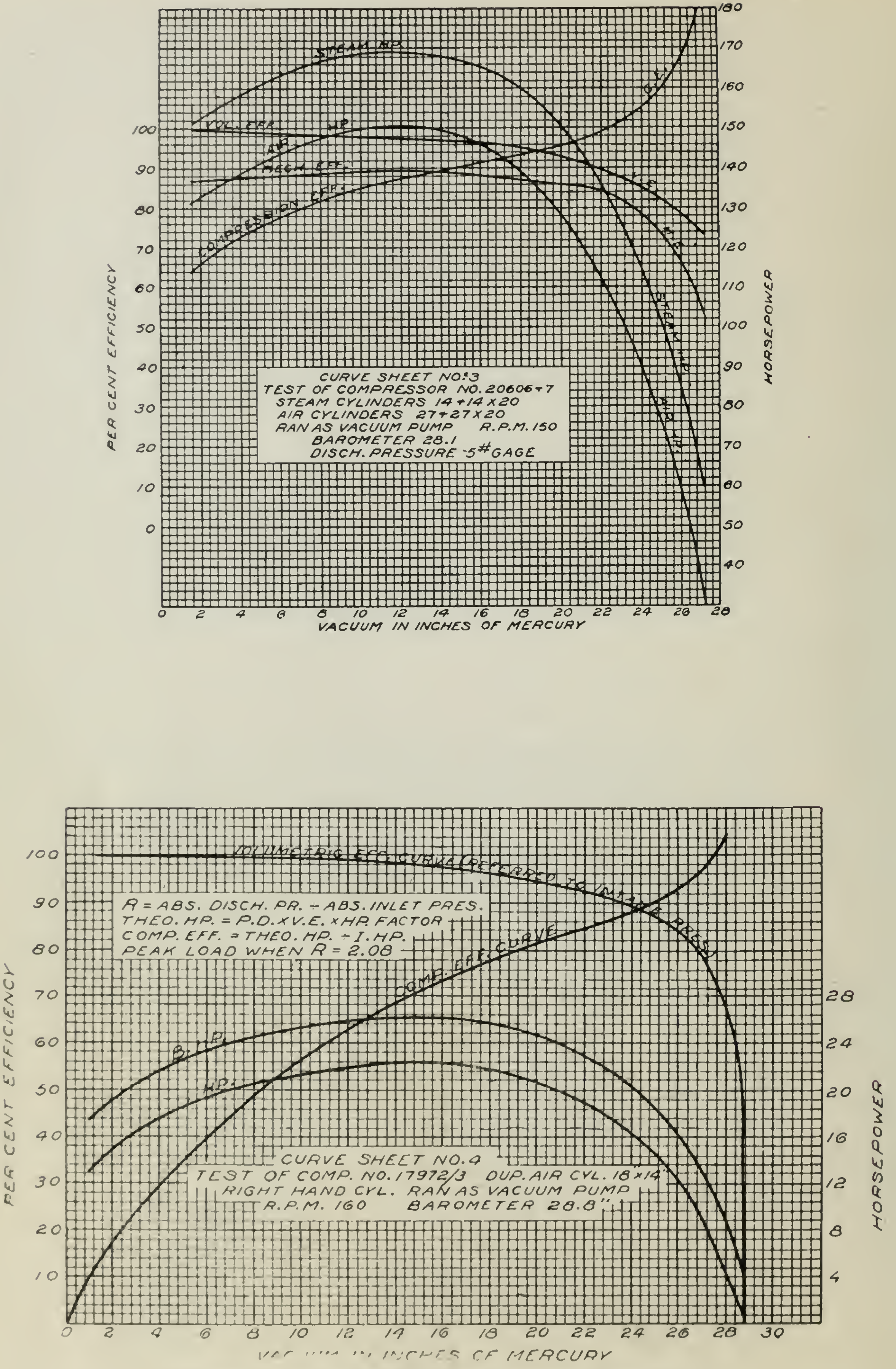
For all the material embodied in this article, and more which space forbade, I am indebted to Mr. A. W. Deyo, Painted Post, N. Y.—*Practical Engineer.*

The patent suit brought against the B. F. Sturtevant Company, Boston, Mass., by the Sirocco Engineering Company, which has been in the courts for the past six years, has just been decided by the United States Circuit Court of Appeals for the second circuit, in favor of the Sturtevant Company. It was claimed that the Sturtevant Multivane fan infringed the Sirocco Company's patents, and in the lower court this claim was sustained. The Court of Appeals, however, reversed the former decision and held that there was no infringement. This court further decided that the Sirocco patents in suit were void in view of the development of the fan-building art prior to the alleged inventions upon which those patents were based.





EFFICIENCY CURVES FROM VACUUM SERVICE COMPRESSOR.



EFFICIENCY CURVES FROM VACUUM SERVICE COMPRESSOR.

MINE SHAFT SINKING IN TOUGH, HARD ROCK

The following relating to hard rock shaft sinking in the Ducktown, Tennessee, copper basin is from a paper of Wm. Y. Westervelt before the American Association for the Advancement of Science.

No water difficulties being encountered, sinking would have presented no peculiar problems had it not been for the fact that the rocks of the district (the ancient graywackes and mica schists of probable Cambrian age) were so extremely hard and tough that shaft sinking in them could ordinarily be carried on only at a very slow rate of progress, while the necessity for rapid exploitation of the newly discovered ore made imperative the completion of the shaft at the earliest possible moment. The difficulty with the rocks was not only their extreme hardness due to silicification and pressure, so that holes could be drilled in them but slowly, but that they were equally tough and resistant to blasting because of micaceous and horn-blendic crystallization. The result was that an excessive number of but slowly drillable holes were required to effect even a moderate cut and an average rate of progress of 25-ft. per month of actual sinking time was until recently all that could be counted upon.

WORKING FROM FIVE LEVELS.

Fortunately five levels, the lowest some 600 ft. beneath the surface, were accessible in the main mine so that by drifting out to the shaft location at each of these levels it was possible to upraise on the line of the shaft at five underground points at the same time that the sinking from the surface was progressing. By this expedient the shaft was actually completed and in operation to the seventh level, a depth of 629 ft. beneath the shaft collar, in the 13 months' time between September, 1909, and October, 1910—a monthly average of over 40 ft. all inclusive.

No workings existing below the seventh level, further sinking had to be confined to work in the bottom of the shaft. Consequently, though every facility then available was employed, the 13 months between October, 1910, and November, 1911, were consumed in sinking the 216 ft. (from the bottom of the sump previously left 15 ft. deep below the seventh level, to the bottom of a sump made 31 ft. below the ninth level) and in equipping the shaft for operation to the lower level—a monthly average of less than 17 ft.

CHANGE OF DRILLS.

During the past summer, sinking below the ninth level was resumed with much improved facilities. The principal improvement was the substitution of Jackhamer drills for the 3-in. reciprocating compressed-air drills previously used. Between Aug. 22 and Nov. 7 (when sinking was discontinued for station cutting at the tenth level), the shaft was sunk 120 ft., from a depth of 31 ft. to 151 ft. below the ninth level, or at a rate of nearly 50 ft. a month and about double the previous best record for progress during actual time of sinking. It is planned to continue the sinking of the shaft to a total depth of nearly 1,200 ft. beneath the surface, to break off an eleventh level 300 ft. beneath the ninth level and to leave some 40 ft. in the bottom for a sump in which sinking can be conveniently resumed whenever desired. The sinking, the breaking off of stations at the tenth and eleventh levels, the timbering and the installation of regular hoisting facilities to the eleventh level will all be completed, it is hoped, early in July, 1915. Should this be accomplished but eleven months will have been required to sink and equip over 300 ft. of shaft and a rate of nearly 30 ft. per month, as compared with the previous 17 ft. per month, all inclusive, will have been attained.

The sinking and reaming from the surface to the ninth level was done with four 3-in. reciprocating compressed-air drills mounted on two shaft bars. These machines were used to drill holes from 5 to 7 ft. deep and made about 5-ft. advance per cut. The present sinking below the ninth level is being done by six Jackhamers drilling holes from 2 to 4 ft. deep and making about 2-ft. advance per cut. The principal advantage in the use of the Jackhamers, as already indicated, is the much greater speed attainable. Minor advantages however are found in a much smoother finished and more easily aligned shaft, and in less violent blasts which occasion correspondingly less damage to the timber of the overhead protecting pentice and leave the shaft walls more solid.

The first 8 ft. below the shaft collar was filled ground. The next 63 ft. was reaming work about a small prospect shaft. The next 99 ft. was unassisted sinking largely in hard rock. Reaming about upraises then carried the work down to the seventh level. The remaining 200 ft. from the seventh to the ninth level was unassisted sinking, as is the sinking now in progress from the ninth to the eleventh level.

For the determination of the location of the upraises from the various levels, a traverse over 2,000 ft. long from the shaft collar into the old mine and out to the shaft at each level was required. In order to avoid the possibility of any serious error in so vital a matter, seven complete traverses were made and checked with each other to within a few inches. The upraises on the center line of the shaft were made about 5 ft. in diameter so that several feet of error in location might have been made and the upraise still have been contained within the 7x14 ft. area of the shaft's cross section. As the contour of the surface made it advisable to elevate the shaft collar 8 ft. above the natural level, the ordinary mine timbering in the near surface soft ground was continued up above the surface for some 20-ft. and made to serve as a head frame to support the sinking hoist sheave. The latter was a Bacon winze hoist operated by compressed air and served to hoist to the surface the rock excavated down the first 170-ft. Below this depth the first upraise delivered the rock to the level beneath and so out through the old mine. This sinking hoist also handled all supplies for timbering down to the seventh level.

Frame timbering of 12x14 in. sets covered by 2-in. lagging was used only to the solid rock 84-ft. beneath the shaft collar. In the solid rock 8x10 in. dividing timbers, set in hitches and dividing the shaft into two hoist and men and pipeway compartments, were all that was required in addition to the usual complement of cage guides, manway platforms, battice between hoist and manway compartments, ladders, etc.

All work has been carried on in two shifts per diem of 9½ hours each. During the sinking from the surface to the seventh level a hoister and a lander were kept on top and eight men on the sinking or reaming work in the bottom. The upraises were made with two telescope feed-hammer drills in each upraise, operated by two men and a steel boy per shift, and the usual complement of trammers to remove the broken rock.

The sinking from the seventh to the ninth level was done from the seventh level by the use of a hoist placed at the latter. The 1,000-lb. capacity steel buckets were dumped into a chute (after closing a trap over the hoistway beneath) and thence directly into the tram cars which were themselves discharged into the regular skips which hoisted to the surface. The men working in the bottom of the shaft were protected from the fall of either a main hoisting skip or a part of its contents, by a pentice placed across the shaft under the two hoistways. This pentice consisted of closely set 12x14-in. timbers hitched into the rock, covered by 4-in. lagging and loaded from 12 to 15 ft. deep with waste rock. Similar arrangements are now installed at the ninth level in connection with the sinking to the eleventh level and in order to avoid any interference with the regular tramming at and the hoisting from the ninth level, the hoistway and chute for the sinking work is confined to the manway compartment of the shaft.

The entire shaft work has been in the immediate charge of our Mine Captain A. Bennett while the surveys were made and the details of the engineering features were worked out by Resident Engineer J. H. Taylor.

The determination of costs per unit on the sinking work now in progress below the ninth level awaits the completion of this work but it is evident from the weekly reports that a marked reduction in cost as well as in time is now being made as compared to the sinking between the seventh and ninth levels. Costs down to the ninth level are submitted below. They include all outlay up to and including that for mine captain and resident engineer whose salaries were included in proportion to

GORDON SHAFT COSTS—FIRST 860 FT. OF DEPTH.

		Per ft.
Preparation of ground and temporary structure.......	$ 760.03	
Piping	5,005.48	
Head frame	2,245.01	
Hoisting plant	20,607.70	
General equipment cost of shaft 860 ft. deep (largely sufficient for shaft when sunk to depth of 2,700 ft.)..	$28,618.22	$ 33.28
Sinking, 338 ft................	17,691.11	52.38
Upraising, 412 ft.............	6,877.40	16.67
Reaming, 475 ft..............	12,905.86	27.18
Station cutting at 9 levels...	15,495.57	•1,721.73
Cutting hitches in 774 ft. of shaft	3,285.76	4.24
Timbering, 860 ft. of shaft...	9,645.71	11.18
Total cost of 860-ft. shaft (including general equipment largely sufficient for shaft when sunk to depth of 2,700 ft.).................	$94,519.63	$109.90

•Per level.

the amount of their time required on the shaft work. The working is known as the Gordon Shaft after the chairman and technical managing director of the company.

THE HYDRAULIC MINING CARTRIDGE

One of the most important of all the employments of compressed air is the driving of rock drills for mining and other rock rending purposes, so that incidentally we cannot fail to be interested in the explosives which are generally employed to complete the work of the drills. There is no reason, therefore, why we should not be equally interested in any substitutes for the high explosives, so far as they can demonstrate their practical efficiency. We accordingly take pleasure in presenting an account of a hydraulic mining cartridge which is said to be actually accomplishing results of value where it is being applied. What follows is chiefly an abstract of a paper by James Tonge in the Journal of the British Society of Engineers.

In the introductory portion of the paper some of the objectionable features of the high explosives are referred to, especially the difficulty of definitely controlling and directing the effects produced. It is for the purpose of avoiding these drawbacks and in order especially to take greater advantage of natural lines of cleavage or of bedding in the material to be dislodged that efforts have from time to time been made to provide what may be termed more rational or scientific means in the shape of mechanical substitutes for blasting.

The simplest form of mechanical means for breaking ground is, of course, the wedge, and this is used in varying lengths and shapes, in metalliferous and in coal mining, in all parts of the world. Various improvements on the simple wedge have been used at various times, viz., the stub and feather and the multiple wedge. The former consists of a steel "stub" or wedge driven in between two tapered lines of steel called "feathers" which have their thin end near the front of the hole. The multiple wedge is placed in a hole previously drilled and has liners also, but a pair of "feathers" may be inserted between them, driven up as far as possible, and then a second or a third "feather" may be used until the rock or coal is broken down. In coal mines, special efforts have been made to devise mechanical wedges capable of breaking down coal, and these have been used to a greater or less extent in a few mines. In some of these the wedge was driven in by means of a screw and handle, like a hand drilling machine, and in one case by hydraulic power.

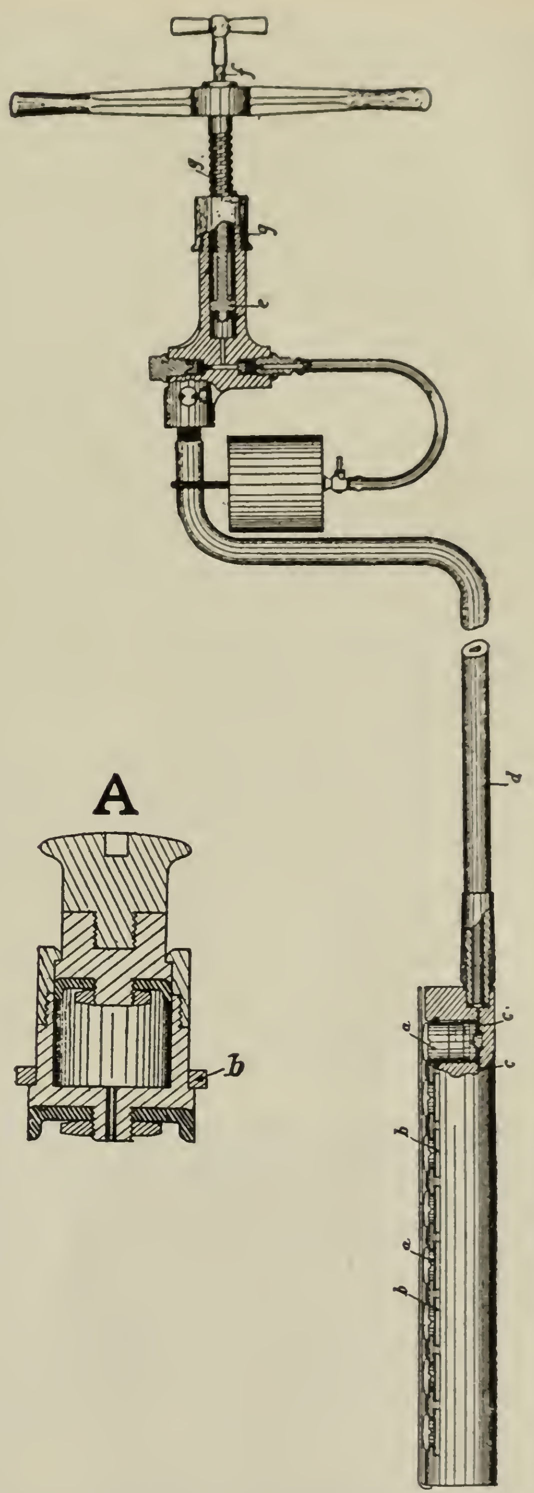


FIG. I. HYDRAULIC CARTRIDGE APPARATUS.

These machines are not now in use and it may be taken that they have proved to be impracticable. This is no doubt due to the great pressure put upon them, even under favorable conditions, and the difficulty of devising and supplying a hydraulic pump capable of working at high pressure for a considerable time.

It must also be remembered that a mechanical wedge must perform more work than that required to wrest the rock or coal from its position, as a certain amount of power is consumed in overcoming the friction of the sides of the wedge as it is driven up. Again, it is a disadvantage to have the material at the front of the hole breaking away as the wedge enters—the full weight of the falling material should, if possible, be utilized to assist the operation. With this object in view, machines have been designed to operate at the back of the hole first, the wedge being drawn outwards and not driven from the front. Except in the case of the simpler forms it may be said that no mechanical wedges are now being used with success for excavating purposes of any kind.

THE HYDRAULIC MINING CARTRIDGE.

The hydraulic mining cartridge (which incidentally calls for an extension of the dictionary definition) differs from all other mechanical substitutes for blasting. It is not worked on the principle of the wedge, and consequently the power expended in forcing a wedge into the hole is saved. Instead of employing a wedge, the disrupting effect is obtained by means of a number of small rams or presses working at right angles from a strong cylinder of steel. (Fig. 1.) In order to make these rams more effective in their operation, by obtaining a greater travel from their original position, they are made of a duplex or telescopic form, one part sliding and fitting upon the other (sec. A). In some cartridges these pistons operate from each side of the cylinder alternately, thus greatly increasing the travel. To retain the rams in position, a sliding plate is used fitting in grooves in the barrel (*b* Fig. 1); this is so formed and secured that it is perfectly rigid and firm when the machine is in operation, but is readily removable if it is desired to detach or replace any of the rams. By a suitable arrangement of passages (*c* Fig. 1) a communication is made between each of the rams, whereby simultaneous action is obtained. Machines are made of various diameters, viz., 2½ inches, 3¼ inches, and 4 inches, and of various lengths, say with 8, 6 or 5 rams, the smaller diameters having the larger number of rams. Pressures of 3, 4 or 5 tons per square inch are usual, so that machines are made to withstand great stresses.

The cartridge is operated by means of a pump (Fig. 1) to which it is directly connected by a pipe (*d*). The pump is of special design. At the commencement of the supply of water it is desirable that the latter should be supplied in such quantities as to fill up quickly all the spaces within the rams and passages, while at the same time allowing the operator, when the rams begin to move and the pressure to increase, to supply a less quantity of water, but at a greater pressure, to complete the final operation of the rams. This is done by having the piston (*e*) operated by the piston rod (*f*) which passes through a supplementary or hollow rod (*g*) and has an appropriate handle for operating the piston within the pump cylinder. By these means the piston may be quickly reciprocated by the user moving the small handle until the desired quantity of water has been supplied or until the pressure to be exerted over the rod (*f*) is beyond the power of the user, when the supplementary rod (*g*) may be brought into use to finish the operation, this advancing by screw motion, and great pressure being obtainable in this way.

METHOD OF OPERATING.

After the rock or coal has been prepared with one or more loose sides and the drill hole of 3 inches, 3½ inches, or 4½ inches, has been drilled to a suitable depth (say three or more feet), the cartridge is pushed in with liners if necessary. The water tank is filled and hung on the pipe, the rubber suction pipe coupled, and the taps turned. The small handle and then the large one are operated as already described. The pressure being fully on, the enormous power of the apparatus is soon apparent, for the rock or coal is heard to be rumbling and cracking. This is allowed to continue until the breaks are of such a size that the mass can be pushed or pulled over and usually is in such condition as to be easily and safely handled.

It is easy to understand that when a shot is fired in rock or concrete, the direction of the breakage will be chiefly in the line of the weakest part. If the material is of uniform strength this direction would be a straight line from the explosive to the nearest unsupported edge. But stratified beds, seams of coal, and walls of stone or brick, are not usually of uniform strength; rock and coal beds contain breaks, cleats, and faces, while concrete beds are invariably irregular in constitution or structure. It follows, therefore, that the line of least resistance is not necessarily the shortest line from the charge to the surface. The difficulty and danger of explosive firing is that whatever this line may be, it is not often possible to make use of it; the pressure generated, though not equally effective, is equally applied in all directions owing to the instantaneous character of the decomposition. This involves high temperature in the explosive gases, a large portion of the heat being absorbed and wasted in the portions which are not capable of being blown down. When mechanical means are employed the time involved in the operation allows the whole of the power to be exerted and applied in the desired direction without waste of heat energy. Not only is power lost in heat energy in the case of explosive compounds, but the result often proves that there has been counter action whereby the rock displacement is reduced through one line of force operating against another, closing in or reducing the area of broken ground.

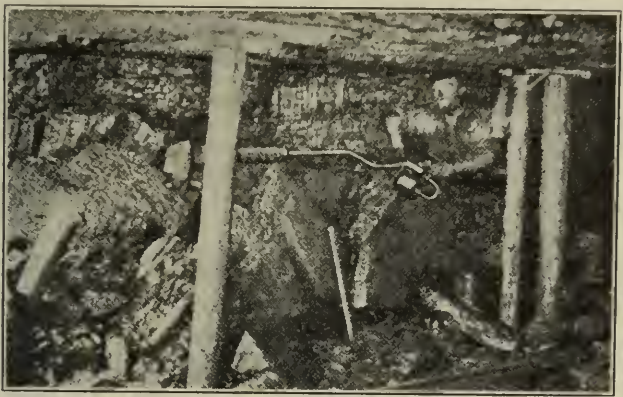


FIG. 2. PLACING A CARTRIDGE.

In practice it is found possible so to arrange the hydraulic cartridge holes as to enable much greater areas of material to be moved than could be done with a safe quantity of explosive, while in some cases the displacement has been greatly extended by the use of small-sized bore holes toward which the slowly developing line of least resistance can assert itself. In other words the power exerted by the rams can be controlled, after a little experience, so that the full pressure can be usefully applied.

USE IN MINES.

The appliance was originally introduced into mines in order to supply the acknowledged need of a different method for bringing down coal in mines in the best possible condition after it had been undercut by hand or machine. The use of high explosives for this purpose, apart from the element of danger, has always been considered undesirable by mining experts, because in using them coal is shattered and wasted and dust made. Now that coal has to be won from greater depth than formerly, and the distances and areas underground increase, the dangers and extent of explosion have proportionately increased, as many recent colliery disasters have shown. The mines in which the cartridge has been chiefly adopted may be divided into two classes:

(*a*) Where the coal is so friable as to render the use of explosives impossible for commercial reasons.

(*b*) Where the condition of the mines in regard to gas, etc., renders shot firing an exceedingly dangerous proceeding.

Of course the question of cost enters very largely into the matter. As is usually the case when a new appliance is introduced, its qualities are quickly estimated from the effects upon the working expenses. At a later stage it will be seen that its effect upon the working cost is slight, while its general advantageous effect upon the selling price of the coal is quite striking. During the past ten years the appliance has been employed in mines in Great Britain, the United States, Russia, Japan, Germany and Austria.

In removing coal a series of holes is drilled in the top of the seam, adjoining and running parallel with the roof. These holes are at intervals determined by working conditions, usually from 6 feet to 10 feet apart and from 3 feet to 5 feet deep. The operator begins at the first hole and pumps off each in succession, usually leaving the supporting sprags to be removed by the collier, who fills the coal thus broken and prepares the coal behind

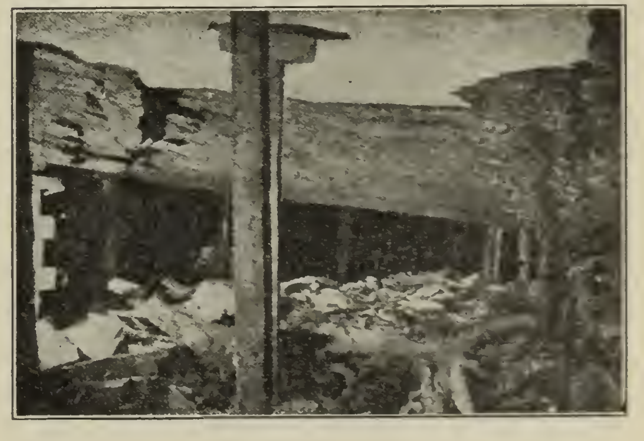


FIG. 3. EFFECT OF CARTRIDGE.

for a repetition of this process. One operator can pump from 30 to 40 shots per working shift of eight hours, using only one machine, which lasts with repairs from three to four years. This procedure is adopted where a large wall of coal has been opened out, and where the coal is got in pillars and headings the process is somewhat modified. The coal across the face of the heading is undercut (almost universally now by a percussive machine operating from a fixed standard) and a vertical slot or "shearing" is cut up the center of the coal, thus providing a loose end. One hole on each side of the "shear" is then sufficient to bring down the coal. The holes are placed as near as practicable to the fast side in order to bring the coal down as near the "fast-corner" as possible. (Figs. 2 and 3 show the cartridge in use in mines).

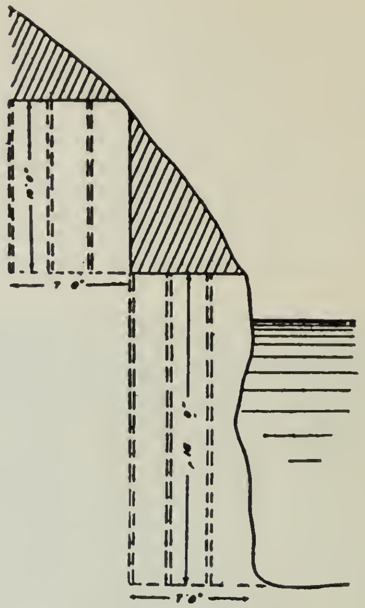
Among the mines in which these machines are at present in use are the following:

Colliery No. 1.—At this colliery an average of over 1,000 explosive shots per week were formerly fired in coal in the various mines. By the introduction of the hydraulic cartridge the whole of the explosive shots have been discarded and there is not now a single shot in coal in any seam. In one seam alone a total of 28,500 hydraulic cartridge thrusts were made in one year, by which it is estimated that 92,626 tons of coal were produced, or about 3¼ tons per thrust. The seam was 3 feet thick and four cartridges were in daily use.

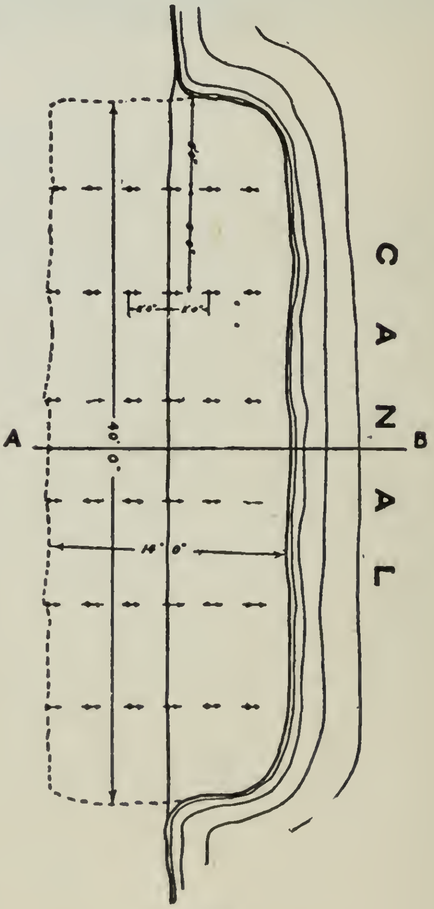
Colliery No. 2.—In a seam using five hydraulic cartridges 450 tons of coal are produced per day, of which 75 per cent. is large coal and 25 per cent. small. When the coal in this seam was brought down by explosives the percentage of large coal was 65 per cent. and the percentage of small 35 per cent. The average price of large coal was 13s., and of small coal 7s. per ton. The profit obtained by the use of the cartridges on this seam on 450 tons is therefore £14 5s. per day. Fifteen machines are employed at this colliery, making a total advantage over explosives of £42 15s. per day. Moreover, an extra 6d. per ton is obtained for the coal brought down with hydraulic cartridges, on account of its greater hardness and freedom from dust.

UNDER WATER.

The appliance has been used in many cases under water, chiefly to remove rock, either from the sides of canals, or from the sides of harbors and docks, where it was obviously impossible to use explosives, the machine being operated from the bank or from pontoons. A typical case will serve to illustrate the suitability of the cartridge for this class of work.



Section on A B.



Plan.

FIG. 4. SUBMARINE WORK.

The rock to be removed was partly projecting from the side of the canal, and it was necessary not only to remove the mass in the water, but also that upon the bank, as shown in Fig. 4.

The rock was New Red Sandsone and the depth to the bottom of the canal 18 feet. It was decided to remove the mass the full depth at one operation. A series of holes was accordingly drilled 6 feet apart, 2 feet 4 inches back from the edge, and 18 feet deep. These were pumped off in succession and the operation of the cartridge at this depth sufficed to break the rock right up to the bank in nearly every case. In one or two holes it was found necessary after operating in the bottom half to draw the machine up about 9 feet and operate again. During the operation divers were below water ascertaining the position and extent of the breaks and directing the operator above as to how to continue the thrusts. The portion shaded (Fig. 4) was removed by hand, and another series of holes was put down 10 feet deep, 6 feet apart, and 2 feet 4 inches from the edge, to break up that portion of the rock to be removed.

In the Alexandra Docks at Newport, and in the new dock at Swansea, the appliance has been used to break up ledges of rock occurring in the vicinity of walls which would have been damaged by the use of explosives. The holes were put in and the cartridges inserted under water by divers and pressure was applied from the pump placed on a raft on the water.

Hydraulic machines have been used for some years at the Dover Harbor Works for the purpose of detaching the large concrete blocks used in the harbor walls. These blocks are of great size and weight. By inserting the drill hole along the bottom of the block and placing the cartridge about half-way under it, the whole mass is slightly lifted and tilted without breaking, and being thus released from its bed is easily lifted on to a wagon by a crane. Machines are being used for a similar purpose in other docks.

Colorado Fuel & Iron Co. has appointed a welfare commissioner, whose duty will be to hear grievances and to act as intermediary between the company and its employees.

THE JACKHAMER IN MICHIGAN COPPER MINES

A "Jackhamer" drill with an improved mounting is being introduced in Michigan copper mines with considerable success. The Quincy about 2 or 3 years back mounted the Jackhamers in shells of their own construction, and some of the other mines are using them in shells designed and furnished by the builders. The Jackhamer part can be very readily removed from the saddle, by unscrewing two bolts, and then can be employed for any of the uses of an ordinary unmounted Jackhamer, being especially handy if desired for block holing. The Jackhamer, besides being able to travel the usual distance of 23 ins. by means of the feed screw, can move an additional distance of 19½ ins. by loosening a clamp in the top of the cone and sliding the shell to the desired setting. This additional travel is advantageous where the character of the ground is such that it will permit the use of long changes of steel. It also enables the use of only two steels for an 8-ft. hole, which makes some saving in time and a gain in convenience.

As the Jackhamer may now be obtained with a water attachment, this mounting really combines all the advantages of the Jackhamer and the "Baby Leyner," a reduced form of the Leyner-Ingersoll weighing 90 lbs., as it can be operated for all the uses of the latter. It weighs about 10 lbs. more (103 lbs.) than the "Baby," but there is some gain in stability. The drill detached is increased in weight 5 lbs. more than the usual form by the addition of the water attachment. It has been received with great favor at the Quincy by General Manager Lawton, on whose suggestion the "Baby Leyner" was designed, and is being tried out, apparently favorably, at some of the other mines.

For over 30 years the two-man Ingersoll-Rand held the stage here, and as late as four years ago hardly any other drill was used. Then came the "Butterfly," so named on account of the butterfly valve, which is capable of extremely rapid action, thereby giving more speed in the drilling. The first of the single-man drills was brought in by Superintendent Ocha Potter, and was given a most successful test by him at the Superior. This was rapidly coming into general use when, as the result of tests of all drills on the market at No. 15

shaft on the Osceola amygdaloid, the Ingersoll-Rand Co., after conference with General Manager MacNaughton, purchased the Leyner patents, combined the hollow piston for the water and the hammer principle of the Leyner drill with the Butterfly valve and adopted the single-man size and weight, producing the machine known as the Leyner-Ingersoll drill No. 18. This type, weighing about 150 lbs., is used in about all of the mines in the district, except where some special pattern is demanded by the character or width of the lode. The "Butterflys" are disappearing as fast as they are worn out. The lighter types are preferred at the Quincy, the mounted Jackhamer, the "Baby Leyner," and now the new mounted Jackhamer being used. There the pressure is 90 lbs., instead of the usual 60 to 70 lbs., which enables them to give a higher efficiency. For the conglomerate, the heavier form of the "Butterfly," D-113, is found to be the best adopted by the Calumet & Hecla. On the Osceola amygdaloid, the Kearsarge, the Isle Royale, the several Hancocks, and Winona the Leyner-Ingersoll is found to best meet the requirements. The "Baby" is used to some extent at the Victoria and the Mass.—*Min. and Eng. World.*

A CLERGYMAN INVENTOR

There passed away, on January 28th, a well-known and interesting personality in the mining world in the person of the Rev. G. M. Capell, Rector of Passenham, Stony Stratford. He was born in Grosvenor-square, London, in 1844, and was a son of the Hon. Adolphus Capell (brother of the fifth Earl of Essex) and the Hon. Mrs. Capell (eldest daughter of Viscount Maynard). He entered the Church and became Rector of Passenham in 1870, which position he retained until his death.

Mr. Capell farmed his own land, and finding on one occasion his haystacks heating, applied artifical ventilation by means of a small hand-driven fan which he constructed in his own workshop attached to the rectory, and by which means he forced air through a pipe to the heated part of the stack, thus successfully overcoming the evil. The construction of this little fan led him to build up a great development of ventilating fans, culminating in the construction of large fans for the ventilation of coal and other mines and for other purposes. He took out many patents for the protection of his inventions, which were a wide departure from the Guibal and other large fans previously in use for mine ventilation, the principal features being small diameter, high speed, curved vanes, and large ratio of inlet to body capacity, thus producing a high efficiency and low oil consumption, and owing to the rigidity of the structure a very low maintenance cost. The merits of the fan were first recognized by the Germans and Belgians, who have now a large number working on some of their principal coal mines, where owing to the restricted airways in the thin seams of these countries the fans were designed to produce a very high water gauge, in some instances as high as 15 in. Some hundreds have also been installed in England, France and America, some of which have been running for twenty-five years with great economy. During the last few years of his life Mr. Capell devoted his attention to propellers for boats and aeroplanes. His genial manner and devotion to scientific matters made him very popular with mining engineers, colliery proprietors and others with whom he came in contact, not only in Great Britain, but on the Continent and America, where he was always welcomed by the principal mining engineers of those countries. His loss will not only be felt from the engineering point of view, but from the social standpoint throughout Europe and America, and the absence of his inventive genius at a time when the development of aeroplanes and waterplanes has reached so important a stage in military tactics will be a loss to the nation.—*The Engineer*, London.

COAL MINE MOVIES

During the past year, the Bureau of Mines, under Charles Enzian, manager of the anthracite division, has been busy preparing views of anthracite operations, and as a result of Mr. Enzian's work the Bureau now has about 3,000 feet, or five reels, which it proposes to loan to mining companies that want to use them, for the small rental of five cents per foot for the pictures, and six cents per foot for the titles.

The pictures were secured at the operations at some of the following coal companies: Kingston Coal Company, Scranton Coal Company, Lehigh Valley Coal Company, Philadelphia & Reading Coal & Iron Company, Susquehanna Coal Company, Lehigh Coal &

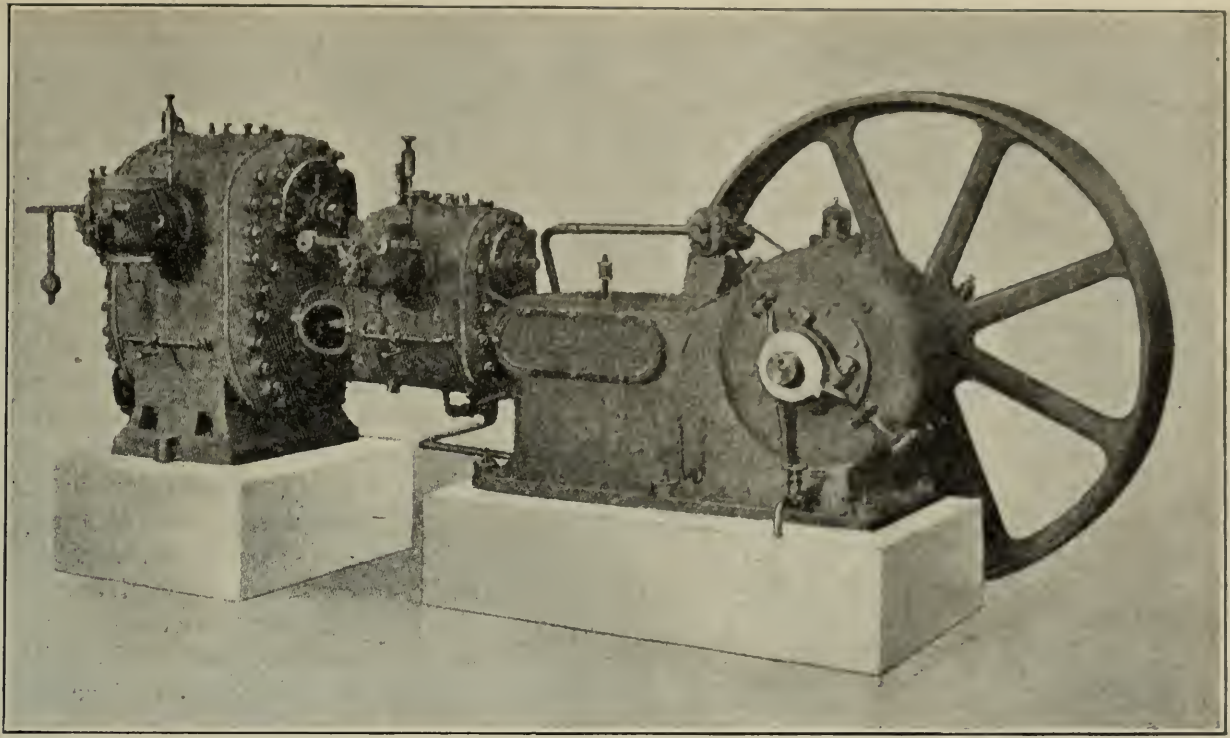


FIG. 1.

Navigation Company, Pennsylvania Coal Com-Company, Lehigh & Wilkesbarre Coal Company, C. M. Dodson & Company, and others.

COMBINED AIR COMPRESSOR AND VACUUM PUMP

An unusual combination of air compressor and vacuum pump has recently been constructed by Tilghman's Patent Sand Blast Company, Limited, Broadheath, near Manchester, for the purpose of pneumatic tube transmission at the Manchester Head Post-office. A description and illustrations of this machine we here reproduce from *The Engineer*, London. Fig. 1 shows the machine externally, Fig. 2 is a sectional elevation and Fig. 3 is a reproduction of a pair of indicator cards from the vacuum cylinder and the compressor cylinder respectively.

The machine is of the horizontal enclosed type and is driven by means of a belt and variable speed electric motor. The pressure cylinder is bolted direct to the enclosed crank chamber and the vacuum cylinder is placed behind the pressure cylinder, being secured to the back cover of the latter by means of a distance piece, which also provides for the true alignment of the cylinders.

As the machine is designed for the relatively low pressures of 27 lb. per square inch absolute in the pressure mains and 7 lb. per square inch absolute in the vacuum tubes,

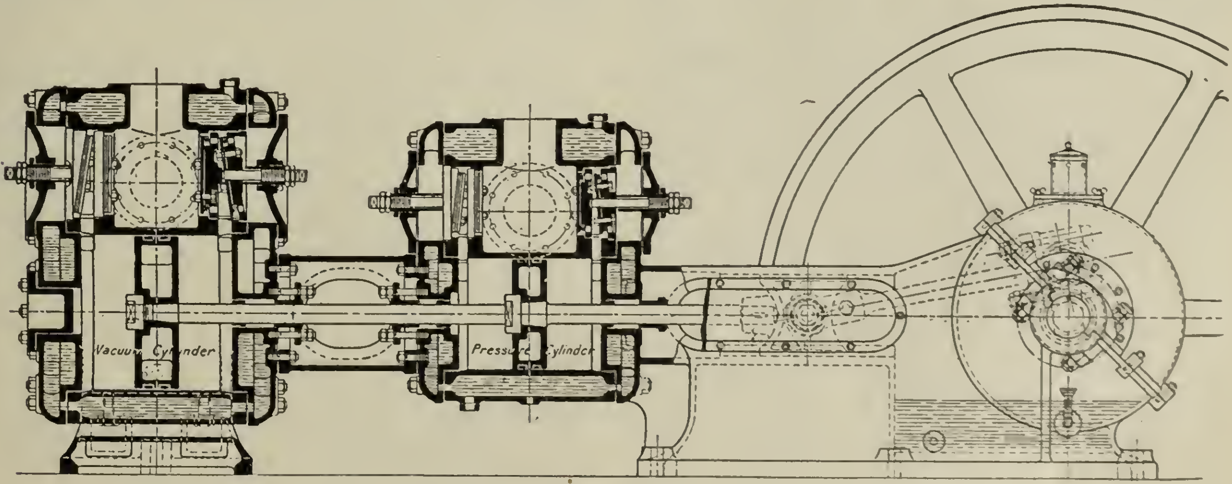
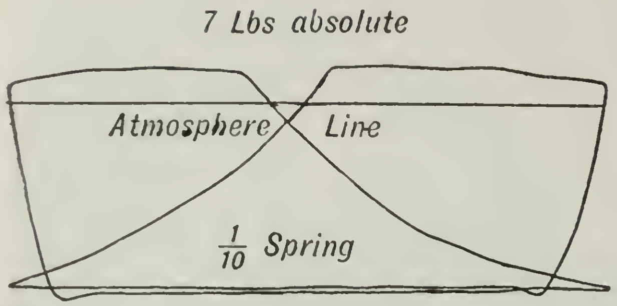
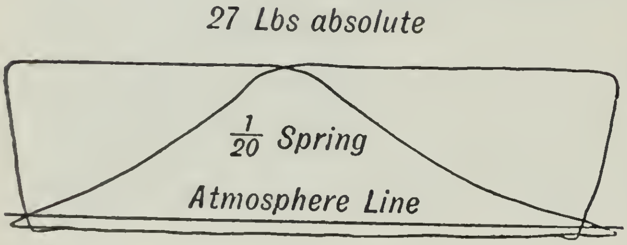


FIG. 2.



Vacuum Cylinder 23" dia. 14" Stroke
130 R.P.M. I.H.P. 22'9



Pressure Cylinder $13\frac{1}{2}$" dia. 14" Stroke
130 R.P.M. I.H.P. 12'6

FIG. 3.

special attention has been devoted to secure a low air velocity through the ports and passages in order to obtain a high overall efficiency. Large water space is provided in the jackets of both the cylinder bodies and covers, the latter being easy of accomplishment owing to the valves being placed in a separate chamber above the cylinders instead of in the covers themselves. Incidentally, this arrangement greatly facilitates the inspection of the valves, which can be taken out in a few minutes by simply removing the covers of the chambers.

Both the inlet and delivery valves are of the automatic multiplate type, specially designed to give an easy and free passage for the air. Each valve consists of a series of perfectly plain thin steel discs working on a removable cast iron seating, a suitable guard plate being bolted to the seating to control the lift of the discs. The two plates next the valve seat are perfectly flat and the others are slightly buckled, forming a very simple and reliable spring. The valves work noiselessly—an important feature in machines situated in the basement of a building. The pressure cylinder is provided with an automatic control valve on the air inlet, by means of which compression ceases when a pressure of 27 lb. has been reached. The vacuum cylinder is fitted with a somewhat similar valve, which comes into operation when the vacuum exceeds 7 lb. These control valves are capable of easy adjustment for any pressures within 2 lb. above or below those mentioned.

The cooling water is circulated through the cylinder jackets by means of a gear shown on top of the crank chamber. This pump has a capacity of 550 gallons per hour and is driven my means of chain gearing from the crank shaft. The lubrication of all the bearing surfaces and motion work is provided by the splash of the connecting-rod end in the oil in the crank chamber. The crank shaft is a steel forging running in white metal bearings with an outer bearing to support the fly-wheel. The latter is 7 ft. diameter and 15 in. across the face. Power is furnished by a variable speed motor of 55 brake horse-power, the revolutions of the fly-wheel varying between 65 and 130 per minute.

The pressure cylinder is $13\frac{1}{2}$-in. bore with a capacity of 250 cubic feet of free air per minute, and the vacuum cylinder is 23 in. diameter with a capacity 700 cubic feet, the length of stroke being 14 in. The following guarantees were, we understand, exceeded by a liberal margin:—Volumetric efficiency, 82 per cent. to 85 per cent.; indicated horse-power in cylinders, 37; horse-power at motor terminals, 49; mechanical efficiency, 75 per cent.; isothermal horse-power, 25.9; and overall efficiency, 53 per cent. It was stipulated that the temperature of the air delivered from the pressure cylinder was not to exceed 160 deg. Fah. with an atmospheric temperature of 60 deg. Fah.

Chemical analyses of starfishes, sea urchins, and crinoids, collected from all parts of the world, show that the skeletons of these animals contain much magnesia. The amount present is found by the United States Geological Survey to vary with the temperature of the water in which the creatures lived. The percentage of magnesia is highest in those specimens that lived in tropical waters and lowest in forms from the icy seas of Greenland and the Antarctic, with a regular gradation between which even shows the local effect of cold ocean currents upon life at the sea bottom.

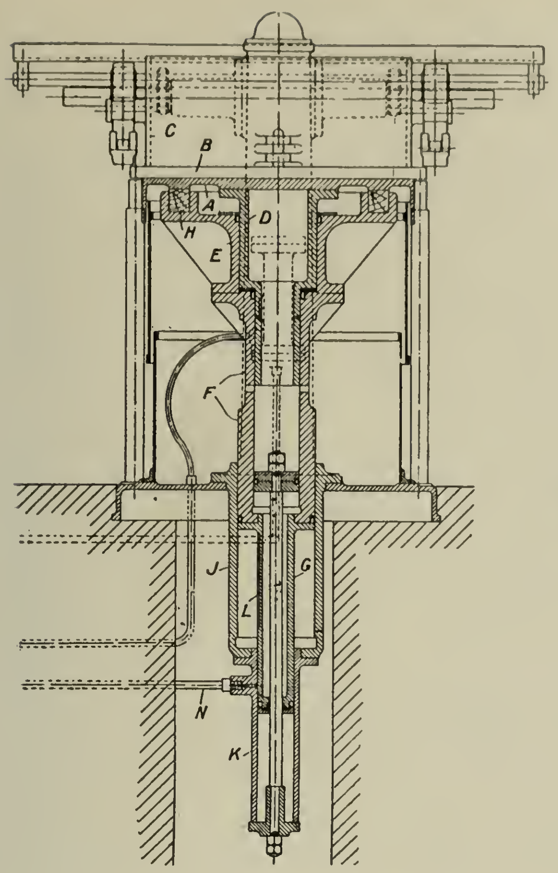


FIG. 1.

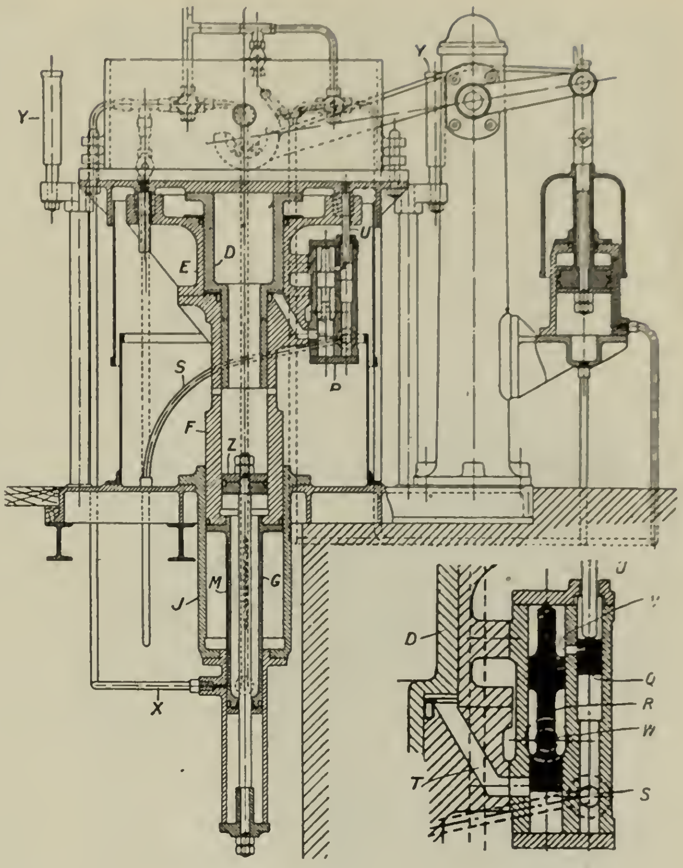


FIG. 2.

AN ENGLISH PNEUMATIC JOLT RAMMER

The accompanying illustrations, reproduced from The Engineer, London, show the essential details and mode of operation of the "Taunton" pneumatic jarring molding machine, built by Rudman, Lancey and Craven, Ltd., Taunton, England.

The machine, intended to be operated by compressed air at 80 to 100 lb. gage, consists of a table on which a molding flask and pattern plate may be placed, of a frame supporting this table but otherwise separate from it, of a jarring cylinder, and of power-operated lever arms intended to facilitate the lifting and turning of the flask and pattern plate when the ramming of the sand has been completed. The action, simply put, is as follows:—The table with the flask and plate in place is raised by the frame a matter of 5 in. or so. It rests in this position, on a cushion of air, as it were, while sand is thrown into the flask. The jarring mechanism is then brought into play. This raises the table up a further distance and releases it. The table falls down to meet the uprising frame, which being momentarily relieved of the weight of the table, is free to rise under the lifting force of the air cushion beneath it. The impact between the falling table and the rising frame constitutes the jar. This jarring action is repeated automatically until the sand is sufficiently compact. When this stage is reached the table is raised a farther distance by means of the frame. The lifting arms are swung over until their ends are beneath the trunnions on the flask. The frame is then allowed to sink, taking the table with it, but leaving the flask suspended on the lifting arms.

In Fig. 1 the table is indicated at A, the pattern plate at B, and the flask at C. At the centre the table carries on the underside a ram-like member D, which fits cylinderwise within the frame. The frame is built up of three parts, E, F, G. The top part is provided with wooden buffers H to take the impact blows referred to above. The part F works within a cylinder J fixed in the base-plate of the machine. The part G, like a tail rod to the piston F, works within a cylinder K attached to the cylinder J. Two vertical grooves are cut on the tail rod, a shorter one L and, a quarter round the circumference, a longer one

M. The engraving shows the frame in its highest position. When in its lowest position air is admitted from the pipe N up the groove L into the cylinder J. The frame, table, pattern plate, and flask are thus elevated about 5 in. until the groove L overshoots the pipe N. The air cushion referred to above is thus established in the cylinder J.

The flask being filled with sand the jarring gear is brought into action. This gear consists of a valve arrangement P fixed to the side of the frame. This valve device automatically and rapidly secures the alternate admission and exhaust of air to and from the cylinder E beneath the ram D. During the admission period the table is raised up, but as the pressure of air within the cylinder E is simply replacing the weight of the table, etc., the frame E F G does not move. As soon as exhaust from the cylinder E occurs, however, the frame is no longer balanced, and is free to rise under the force of the air cushion within the cylinder J to meet the descending table as mentioned above.

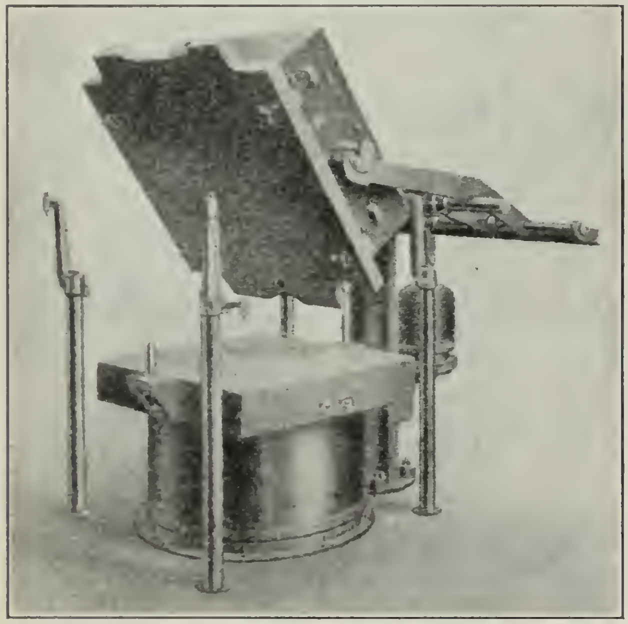


FIG. 3.

The action of the jarring valve is interesting. It consists of two piston valves Q, R, of which one, R, is of the differential type —see the enlarged view, Fig. 2. To bring the jarring gear into action air is admitted from the pipe S to the underside of both valves. The two valve chambers, it must be explained, are in communication at their lower ends, presumably by a hole not shown in the engraving. Both valves are thus forced up to the tops of their strokes, while the air also finds its way along the passage T to the underside of the ram D. The ram and the table are thereby carried up. Attached to the table there is a depending rod V which entering the jarring valve casing forms a stop for the valve Q. As the table and the rod V rise, therefore, this valve Q is free to follow up the motion under the action of the air beneath it. After a certain rise the valve uncovers a passage V leading into the chamber of the valve R near its upper end. Air is thus admitted to the top of the valve R and as the upper diameter of the valve is greater than the lower the valve is forced down to the bottom of its stroke. In this position it sets the passage T into communication with an exhaust port W. This brings about the fall of the table and, of course, of the rod U. The valve Q is thus forced down by the rod until a small port in it opens the port V to exhaust—the rod U, it will be noticed, has a good clearance in its hole in the valve casing cover. With the pressure on top of the valve R relieved in this manner the air from the pipe S is once more free to raise the valve to its highest position.

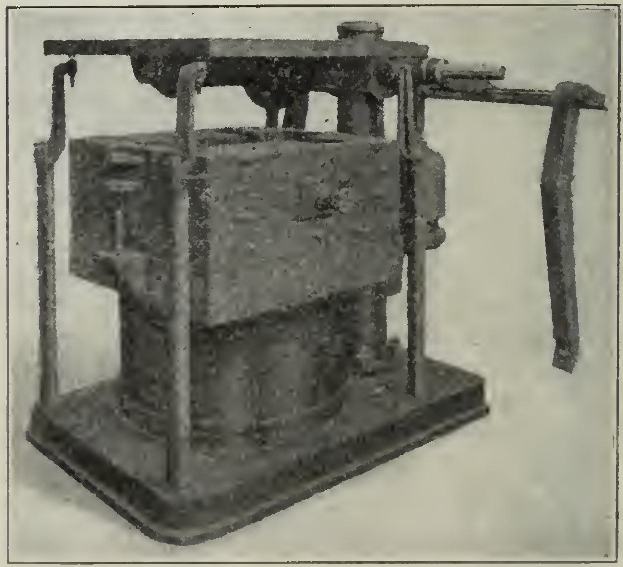


FIG. 4.

The cycle is then repeated and will be kept up so long as the air supply to the pipe S is maintained.

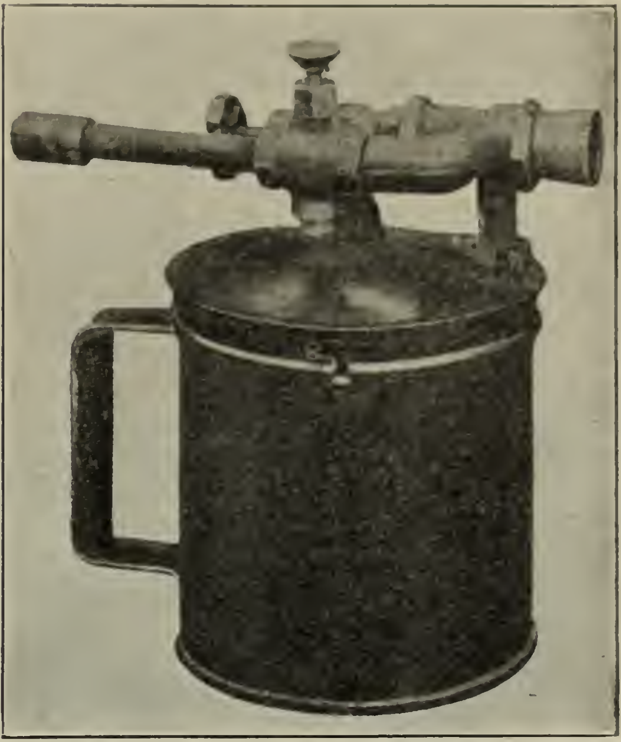
The sand having been sufficiently rammed, air is admitted from the pipe X, Fig. 1, up the groove M into the cylinder J. This brings about the farther rise of the frame and table referred to in our preliminary outline of the action. If the pattern plate is suitable the four eccentric arms Y—see also Fig. 3—may be swung round until they come beneath the corners of the flask. Then by exhausting the air from the cylinder J through the pipe X the frame, table and pattern plate may be lowered, leaving the flask, inverted, resting on the arms Y. It may, however, be desired to turn the flask over before the pattern plate is withdrawn. This is effected by sliding the power-operated lever arms, as shown in Fig. 3, along their fulcrum shaft until their ends engage the trunnions on the flask. The flask and the pattern plate may then be elevated by power, turned over and lowered again on to the table. The eccentric arms Y would be swung in to engage the corners of the pattern plate so that on exhausting the air from the cylinder J the flask would descend with the table, leaving the pattern plate behind.

Owing to a certain leakage, whether by design or not, the frame always rises until the groove M slightly overshoots the end of the pipe X, which in practice gives a very desirable result, for on exhausting the air from the cylinder J the small overshot portion secures a period of very slow descent for the frame and table, followed by a rapid movement as soon as the overshot portion gives place to the groove M. It thus happens that the joint between the pattern and the metal is parted very gently.

The interior of the tail piece, along with a piston Z working within the portion F of the frame, is made to constitute a dashpot, and air is allowed to leak into this through a tiny hole, which addition prevents the frame from bouncing on the cushion of air in the cylinder J while the mold is being rammed. Although the ramming of the sand is effected by a jarring action, the impact occurs in mid-air, and the floor is not shaken. Figs. 3 and 4 show a machine of this type handing flasks 2 ft. 4 in. square and 14 in. deep and weighing, with sand and pattern plate, about 800 lb.

A VACUUM PAINT SPRAYER

This so-called "vacuum" paint sprayer is not so much of a vacuum apparatus after all. It is connected by a light hose to the regular compressed air supply of the shop, and this air as it pases over certain holes in the horizontal pipe induces a vacuum in the tank and draws up the paint into the current of air.



VACUUM PAINT SPRAYER.

The quantity of paint delivered is regulated by the valve shown, and a push valve controls the flow of air. No skill is required for operating the device, and the only requirement is to keep it clean and not allow it to be clogged up by the hardening of the paint when it is not in use. It is put on the market by the Gustin-Bacon Manufacturing Company, Kansas City, Missouri.

A TYPICAL WATERWORKS AIR LIFT

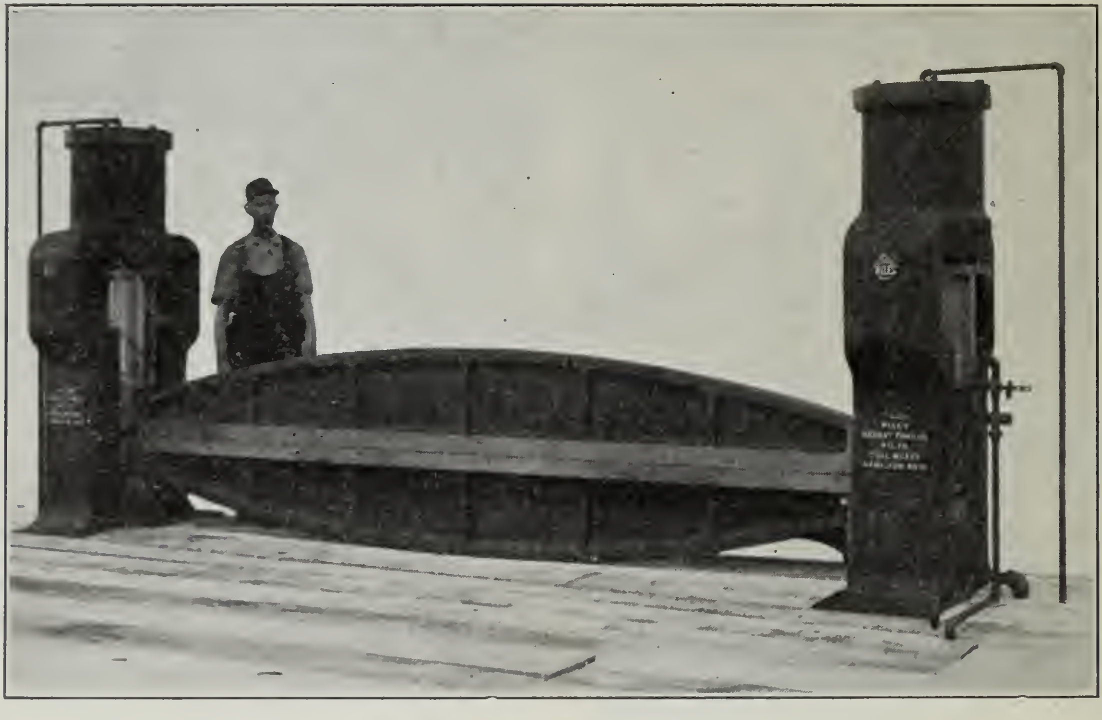
At the Madison, Wis., waterworks there are four wells; two, 8-in.; one 6-in. and one 5-in., all 750 ft. deep and cased to a depth of 150 ft. The static head is 30 ft. and the lift above the surface 12 ft. The wells were piped for air lift on the basis of 60 per cent. submergence, or 172 ft. The air compressor recently installed for this service is an Imperial two-stage, short belt, electric drive machine with air cylinders 19 and 12 in. dia. and 16 in. stroke, driven by a 150 H. P. Westinghouse 220 volt, 3 phase, 60 cycle motor. The air receiver provided is 48 in. dia. and 8 ft. high.

The yield from these wells is variable, producing all the way from 157 gallons for the 5-inch well up to 768 gallons per minute for one of the 8-inch wells, the total production being 1,947 gallons per minute. Harris 20th

Century Air Lift Pumps were used in all the wells, placed at varying depths from 255 to 265 feet. The starting pressure varied from 98 pounds to 102 pounds. An output of 2,500,000 gallons per day was guaranteed, with an efficiency of 35 per cent. At the test the results secured were as follows: Total gallons pumped 24 hours, 2,803,680; measurement over knife-edge weir and hook gauge; E. H. P. input to motor, 160.8; water H. P., allowing for friction in discharge line, 57.5; efficiency, E. H. P. input compared to work done, 35.6 per cent.; K. W. used per hour, 120; gallons per hour, 116,820; cost per K. W., $0.01; cost per 1,000 gallons, $0.0102; cost per million gallons, $10.20.

A PNEUMATIC PLATE FLANGING CLAMP

The half tone on this page shows a plate flanging clamp for boiler shops, taking plates 12 ft. wide, built by the Niles-Bement-Pond Company, New York. Clamps of this general type have been built for a considerable time, but using the air pressure only for raising the beam, and doing the clamping by screws and hand wheels. In the present design there is a small piston in each standard below the beam for raising it and a large piston above for applying the necessary clamping pressure which will amount to 15 tons with an air supply pressure of 80 lb. A single valve controls the entire upward and downward movement and clamping effect. The contact of the pistons with the beam ends is by circular arc surfaces which permit an equitable application of the clamping pressure if the plates clamped are not of uniform thickness. The clamp is built in several different sizes. The cost for operating this device is practically nothing for labor and not more than one cent for the air consumed for each clamping operation.



PNEUMATIC PLATE FLANGING CLAMP.

SANITARY LAUNDRY PRACTICE

Quite a number of small "sanitary" laundries in New York City advertise "open air drying." In contrast with this a laundryman in Burlington, Iowa, advertises as follows: "A balloon ascension in your back yard would be your only means of drying your clothes away from the dust of the city streets and the deadly fly. Our hygienic dry-room contains hot, filtered, circulating air—no flies, no dust, no germs. The laws of health demand that you either send up a baloon every wash day or send your family washing to Sickels New Method Laundry.

For the year 1913 there were imported into the United States 1,502,795 gallons of peanut oil, and in 1914, 1,016,863 gallons. The 1913 importations were valued at about 70c per gallon.

THE UNDERGROUND WORK HABIT

"I've been working away underground for the last twenty years, and not in a mine either," said one of the sub-bosses of the new subway under construction the other day. "I began away back on the original Hudson River tunnel.

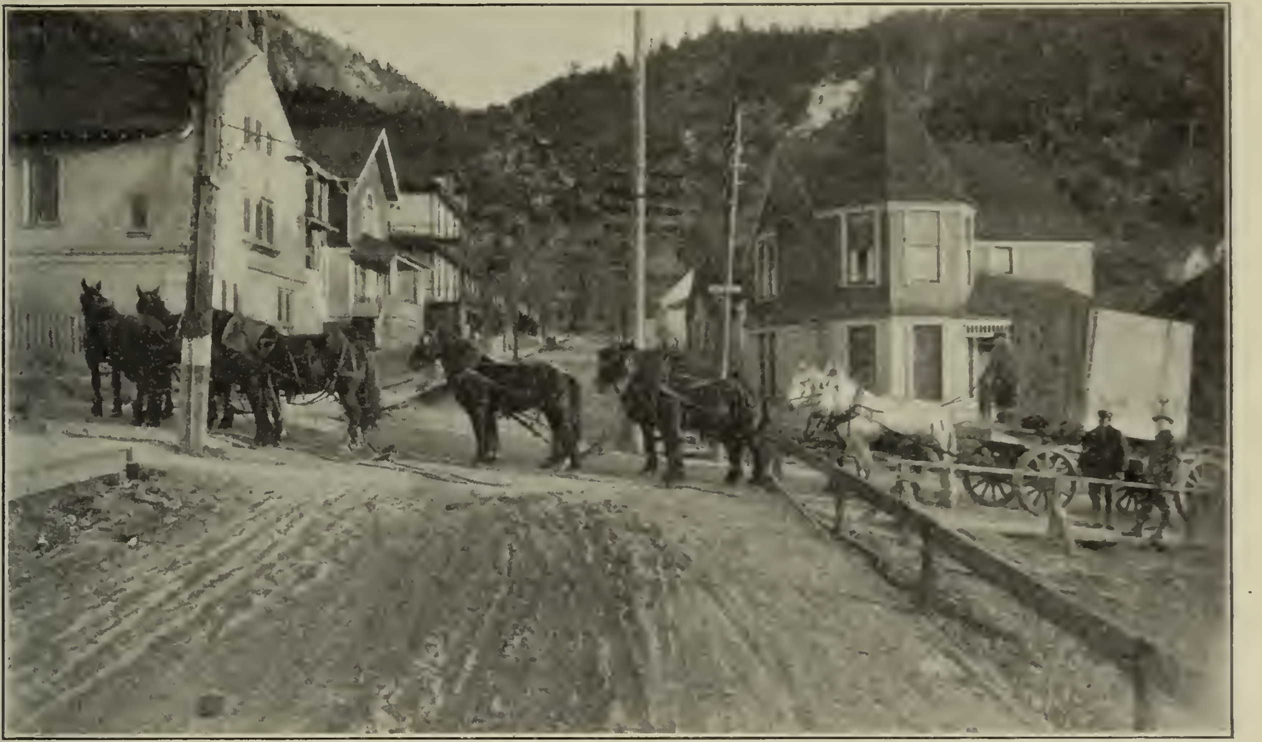
"I worked at that until the first subway contracts were let. That took me under ground again. When these lines were completed about eight or nine years ago I went to work in Chicago on below the surface work until the new subway contracts had been let. Now I'm in full underground swing again.

"I spend over eight hours every day with several feet of dirt over my head. I have not seen a ray of sunlight during working hours for years. I don't know that there is day between 8 a. m. and 5 p. m. I measure everything in my mind by darkness and night systems of measurements.

"Things don't seem right up on the earth's surface. The sun's too odd a thing to stay with long. It makes me blink too much. The shade and the darkness of the underground area seem much more adapted to my nerves and needs. The glaring light upstairs is too brazen altogether.

"Down where I work it gets you to feeling as the subdued lights impress you in some of these restaurants where everything is arranged to convey the idea of rest and comfort. I don't feel at all like Germany—wanting a place in the sun. Downstairs, apart from the hurly-burly, burrowing to make connecting links for transit suits me."

A number of men who have spent years in underground work declare their health has been all that could be desired. Some have grown stouter at it and some are actually rosy cheeked.



ALASKA UP TO DATE.

A HIGH CLASS COMPRESSOR IN ALASKA

The photo on this page comes to us without much specific data, but it tells a clear story of its own. The scene is on Gold street, Treadwell, Alaska, and the fine team of ten horses is hauling a truck with a load of 18,000 pounds, one cylinder of an up-to-date air compressor. The technical designation of the machine is PRB2., a two stage, Royler valve, electric driven compressor with all the improvements which make for efficiency, economy and reliability for the service of the Alaska Treadwell Gold Mining Company. The scene presents many details of interest as suggesting the refinements of civilization, enterprise and comfort close up to the Arctic Circle. At the extreme left is a fire hydrant and near it is a steel telephone pole. The number of telephone wires is worth noting. The buildings on the left are apparently a church and then a schoolhouse, or vice versa; the building with the balconies may be a hotel, and so on. The inhabitants are conspicuous by their absence, but they may have been temporarily excluded for the sake of the picture.

SUCCESS OF THE BOTTOM HEADING IN SNOQUALMIE TUNNEL

Both the top-heading and the bottom-heading methods were used in driving the Snoqualmie tunnel of the Chicago, Milwaukee & St. Paul Railway 40 mi. east of Seattle. The former method was used at the east end and the latter at the west. Although the top heading showed a slight advantage in average progress, the removal of the bench was more readily accomplished with the bottom heading.

Work on the tunnel began at Rockdale late in 1911, but was not pushed rapidly until after the very severe winter of 1912-13. Since that time four 6-hr. shifts have been kept in each heading, and the total force at the tunnel has averaged more than 300 men. Steady progress was made up to the time headings met on Aug. 4, 1914.

The tunnel is a single-track bore 11,902 ft. long, having one portal on the western slope of the range at Rockdale and the other near Keechelus. The saving in distance will be about 3½ miles, and 1,239 deg. of curvature will be eliminated. The tunnel is being built on an ascending eastbound grade of 0.4 per cent to a point 2,000 ft. west of the east end, whence eastbound traffic will descend a 0.1 per cent. grade to the portal.

All of the material encountered during the driving was rock, carying from soft to very hard; about 75 per cent. of it was a massive black slate and the remainder quartzite and conglomerate. At the west end the bottom-heading method was used, all of the material above the bottom heading, 8x13 ft. in section, being blasted and dropped to stoping timbers and thence into cars on the track below. At the east end a top center heading, 8x6 ft. in section, was driven first and muck was loaded into cars on the high-line tracks. At the west end gasoline motors and steam dinkies handled the muck in 1-yd. and 1½-yd. cars, while at the east end electric motors and steam dinkies were used in the interior and exterior workings respectively. The engineers report that the bottom-heading method proved much more satisfactory in many ways. The average progress with the bottom-heading method was 9.5 ft. per day as against 10 ft. per day with the top-heading system; the bottom heading could not be driven faster than the top, but the removal of the bench was more readily accomplished.

Each heading was drilled by four Ingersoll-Rand piston drills mounted on a cross bar, and from sixteen to twenty-five holes were placed for each round. From 2 to 8 lb. of 60-per cent. gelatine dynamite were used per round, according to the class of rock encountered, and all blasting was done with fuse and caps. Ventilating fans housed at the portals provided ventilation by drawing out powder fumes through a 20-in. galvanized-iron pipe that terminated at the end of the completed bench. In addition to this fresh air was forced into the heading through a 10-in. galvanized-iron pipe line, canvas hose being substituted for the 60 ft. next to the heading. As the distance between portal and heading was increased, the pressure in the air lines was maintained by adding motor-driven booster fans as required.

All of the work, with the exception of the 2 miles of approach grading, has been done by company forces under the personal supervision of J. I. Horrocks. E. O. Reeder, at Seattle, Wash., is assistant chief engineer, and C. F. Loweth, Chicago, is chief engineer of the Chicago, Milwaukee & St. Paul Railway.—*Engineering Record.*

COAL ECONOMY IN CENTRAL STATIONS

According to a committee of the Association of Edison Illuminating Companies, the average consumption of fuel in all the central stations of New York City is at the rate of 3.3 pounds per kilowatt-hour (2.46 pounds per horse-power hour), inclusive of all standby and other losses. The average consumption of fuel by isolated plants is at the rate of not less than 10 pounds of coal per kilowatt-hour (7.46 per horse-power hour), or three times (the average rate of central station operation. It is claimed that, as compared with isolated plants, central station generation of electricity is conserving in New York City alone about 1,750,000 tons of fuel a year.

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DEATH OF EBENEZER HILL

Ebenezer Hill, practically the founder and for so many years the engineering and business head of the Norwalk Iron Works, South Norwalk, Conn., died at his home, Danbury, Conn., after an illness of several months, 66 years old.

We regret exceedingly that we have been unable, as yet, to procure the materials for a satisfactory obituary notice. We know that as to his schooling he was a graduate of Wesleyan University, B. A., 1870; M. A., 1891. His so-called professional record in the files of the American Society of Mechanical Engineers, in connection with his application for membership in 1892, is absurdly sketchy, incomplete and unsatisfactory, and nothing can be learned from it. He was manifestly so fully entitled to membership that it was not at all necessary to scrutinize any written record.

Mr. Hill was one of the pioneers in the developing of the modern commercial air compressor. Besides the designing of his machines he especially did excellent work in familiarizing customers and the general public with the conditions essential to be observed to secure economical air compression. His hobby, as it might have been called, was two-stage compression for the ordinary working pressures used for driving rock drills and similar service.

The early publications put out by him, and similiarly those which have successively followed them, in advocacy of compressors embodying this one principle of two stage compression, are among the most convincing in that class of publications. If they may be said to have been too convincing, in that they have insisted rather too much upon the losses acompanying single stage compression and have given an exaggerated impression as to the magnitude of the savings of power and otherwise in two stage compression, while they have had comparatively so much less to say about the much larger economics possible to be secured in the steam end of the compressors, it may well be argued that these latter were already, or should have been, sufficiently familiar to all well informed engineers.

Nevertheless it is by such pushing as this that knowledge and practice are advanced. From full exparte arguments upon both sides, the advocates of either having said all that possibly can be said, the truth must surely be established. Certain it is that within the active life of Ebenezer Hill—and he would hardly be called an old man—there has been a wonderful advance in compressed air practice; in the compression, the conditioning, the transmission and the ultimate profitable employment of the air, and Mr. Hill contributed substantially to the acomplishment of the result.

NEW VOLUME REGULATOR FOR AIR COMPRESSORS

The paper with the above title by Raynor Wikander, presented at the December meeting of the American Society of Mechanical Engineers and printed in our issue for January, was the only paper dealing specifically with a compressed air problem. We present below the discussion which the paper elicited, from the Journal of the Society.

W. L. Saunders, in a written discussion, stated that he regretted the author had given so little space to the system of clearance unloaders or controllers, which the writer claimed to be not only extremely simple and inexpensive, but had been demonstrated to be highly efficient.

He stated the cardinal requirements for the successful operation of a regulator for high speed compressors operating at constant speed are:

First, underload regulation must be obtained with such a degree of economy that the reduction in power required will be practically in a direct proportion to the reduction in output capacity.

Second, all mechanisms for regulating the compressor must be independent of the running gear of the compressor, otherwise the timing of the regulator as the regulation varies is difficult to accomplish, and the delicate yet durable mechanism required, operating at the full speed of the compressor continuously, is extremely difficult to design and manufacture. The difficulty and cost of maintenance and the shut-downs requisite for repair have proved excessive when the regulating mechanism is part of or dependent upon the running gear of the compressor.

Third, the regulator should be of such design that, when the compressor is called upon for average operation at partial load capacity, it can be so adjusted by hand as to limit the maximum capacity, and thus permit the compressor to operate at a higher average capacity or higher load factor than would otherwise be possible. This is a valuable feature under conditions where electric power service is furnished under a special maximum demand charge.

He stated that with the automatic clearance controller the inlet capacity of the compressor is reduced without reducing the intake pressure. On a two-stage compressor a constant ratio of compression throughout the entire load range, and the highest compression efficiency, is maintained throughout. The reduction in power secured with this method of control is practically in direct proportion to the reduction of load. The regulator is simple in construction and entirely automatic in operation.

On account of its under-load economy, the automatic clearance type is in his opinion of value in the majority of conditions of constant speed power-driven compressor service requiring under-load regulation.

Joseph Esherick wrote congratulating the author upon his excellent paper and for his work in developing the Hall volume regulator.

In regard to volume regulators, he said the author made no mention of the Richards Pressure Unloader. This unloader permits the compressor to run unloaded until the desired speed is obtained, when it loads the compressor automatically. The device is placed in the discharge line between the compressor and receiver and is simple and inexpensive. It is used primarily on motor-driven compressors. Another type, called the Initial and Pressure Unloader, has been designed for continuous running steam and electric-driven compressors. This embodies means of adjustment for any degree of regulation, from two to fifteen pounds.

Paul Diserlns wrote that the author's objection to the choking unloader were well taken as directed against its application by gradual throttling, but that this application was practically obsolete. They were not well taken in the case of the total closure unloader, which is both safe and efficient when properly protected by atmospheric relief valves. The only drawback to the total closure unloader is the sudden change from full load to no load it causes, but where this is not objectionable at the electrical end the device answers very perfectly.

Theoretically the principle of varying the capacity of a compressor at constant speed by changing the clearance (clearance unloaders) is sound. The writer sees, however, the chief objection to the practical application of this principle for volume control in the obstruction to free communication between cylinder and clearance chambers occasioned by the restricted valve openings, of necessity interposed between cylinder and valve pockets.

The author's comment on unloaders on compressors with positively moved valves implies that unloaders operating the suction valves are the best type, whereas one of the most widely used devices of this nature involves an auxiliary by-pass valve and connections.

The volume regulator which is the subject of the paper appears to depend on the gradual increase, during the entire length of the compression stroke, of the cylinder pressure as compared with the suction passage pressure, but it does not seem clear why such gradual increase should occur.

It would also appear that on compressors of medium and larger sizes, operating at the relatively high speeds now generally employed, a multiplicity of valves equipped with by-passing control would be needed. This would appear to present some difficulty in synchronizing their action.

The application of the regulator described to a two-stage compressor necessitates the use of two independent governors, one to regulate the line pressure and the other the intercooler pressure. Though this does not constitute a serious objection, it implies a complication to which the author takes exception in other forms of volume control.

James Tribe expressed his written opinion that the form of valve to which this regulator was shown applied might operate with fair success under low-speed conditions such as formerly obtained, but in modern compressors running at say 150 r.p.m. such a valve must have a very short life. Even the pressed steel cup valve, used for many years by the best builders on account of its lightness, was proving too massive to withstand the shock incident to valve action with high speeds.

John Glass contributed a written discussion in which he said the Hall regulator would not apply to a pipe line as to a tank, as it is not practical to carry a constant discharge pressure at the various compressing stations of large gas-pumping plants. In such installations, the gas pressure is partly regulated at the compressing plant closest to the point of consumption, but the other plants back on the line are run at constant speed, that is, compressing all the gas possible. If more pressure is required in the line extra wells are turned in, and if the unloading device is affected by this, shortage of gas will occur at the consumption end.

He thought that this regulator was well adapted to gas engine driven compressors, especially in starting, and also on account of the limited capacity of the gas engine for overload, but that it was not of very great advantage in gas-pumping plants, as the changes in pressure are too great. When the field pressure drops the discharge drops also, giving about the same number of compressions. A large diameter compressor would be a disadvantage as the speed would have to be reduced so as not to exceed the economical number of compressions, about 4.5.

Frank Richards said that the device described could only be used in connection with obsolete or obsolescent types of inlet and discharge valves. He said we have learned that poppet valves are by no means the best for air compressors. The poppet valve has considerable inertia, and moreover the resistance of a spring has to be overcome in opening it; oil gums its guides and the valve requires frequent examination and cleaning; it gives a more or less restricted and tortuous passage for the air, and this feature is accentuated when the air has to play back and forth for regulation purposes. With this valve, too, the pressure of the air within the cylinder is necessarily lower at the beginning of the compression stroke than that outside.

The Corliss inlet valve, wide open for nearly the entire stroke, and with large port area and a direct passage for the air into the cylinder, gives a freer inrush to the air and a fuller pressure at the beginning of the compression stroke.

The Rogler valve, which has replaced the poppet valve, annihilates its objectionable features without entailing others. This valve consists of a very thin steel plate covering concentric annular openings in the valve seat, and with a minute, free lift it gives the largest and freest passage for the air that has ever been realized. The Hall regulator cannot be applied to either this or the Corliss valve.

The regulation of a compressor should be accomplished without interference with its ordinary operation, and so it might be well that neither the inlet nor the discharge valves should be interferred with for this purpose. This may be secured by controlled changes of the cylinder clearance, an almost ideal mode of regulating the output from nothing to full delivery. It is possible mechanically to have an automatically pressure-adjusted changeable clearance for the air cylinder so large that at one extreme of its capacity a whole cylinderful of free air shall, when compressed up to receiver pressure, just fill this clearance space and none be expelled to the receiver. Then the compressor could run along continuously, and the air in the cylinder would be alternately compressed and re-expanded and no power expended.

A partial reduction of this clearance space would compel an expulsion or delivery of a portion of the air, and the remainder would re-expand upon the return stroke the same as with the clearance of full capacity, but in the latter case at the end of the stroke a portion of free air would be taken in sufficient to replace the volume delivered, and so on. With this adjustable clearance reduced to its minimum, the cylinder would be delivering its full charge of air, and its action would be entirely normal.

Such a clearance control is not yet fully realized, but the four stage clearance controller already in extensive use gives highly satisfactory results in practice. The only expense it involves is its initial cost, as it requires no constant operating expense.

EXHAUST STEAM ECONOMY IN A SHIPYARD

At the plant of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., a 1400-kw. (1830 h. p.) De Laval low-pressure turbine, operating at 3000 r.p.m. drives two 700-kw. direct-current dynamos at 500 r.p.m. The turbine is of the pressure stage type and receives the exhaust from air compressors and hydraulic pumps, exhausting in turn into a surface condenser. In this installation the dynamos are mounted with their shafts parallel to each other, with the result that a compact arrangement of apparatus is secured and the pressures on the bearings and gear teeth are reduced. The normal yard load of approximately 1000 kw. at 220 volts is regularly carried by the turbine-driven generators, while when pumping out a dry-dock the combined load of approximately 2300 kw. is carried by connecting one of the original 600-kw. engine-driven generators in a series with the turbo-generator, thus supplying approximately 500 volts, for the two large motors in the dock pumphouse. In this way, it is pointed out, the economy of a turbo-generator set is secured for ordinary operation, and the existing engine-driven units are not discarded but are utilized as spares.

EFFECT OF DIFFERENT PRESSURES AND TEMPERATURES IN OXYGEN CUTTING

BY J. F. SPRINGER

In connection with cutting iron and steel with an oxygen jet, the question arises whether any considerable advantage would result from pre-heating the gas. In those types of cutting torches in which the cutting oxygen is surrounded by an oxy-acetylene flame, a certain amount of pre-heating does take place. One should expect that such cutting torches would show a high degree of efficiency, and certain experiments carried out with the oxy-hydrogen cutting torch having separate jets and the oxy-acetylene cutting torch with a centrally arranged oxygen jet seem to justify this expectation.

The steel experimented upon was an open-hearth plate having a thickness of 1.18 inches. It was found that the former type of torch required 50 per cent. more oxygen than the latter in burning out equal volumes of material from the cut. This difference is too great to assume that the whole of it is due to any difference in effectiveness of the oxy-hydrogen and oxy-acetylene systems. It must be in part assigned, so it would seem, to the difference in the arrangement of the jet of cutting oxygen.

While the foregoing evidence is mainly suggestive, and by no means to be regarded as conclusive, it does prepare the mind for the results of other experiments where all the tests were carried out under the same system. Two comparative sets of experiments were tried, the type of torch in both cases being an oxy-acetylene instrument having a centrally arranged cutting jet. Whatever advantage may lie in the pre-heating of the cut ting oxygen due to this arrangement is common to all the experiments. For the present, therefore, this is not to be regarded as preheating at all. In both sets of experiments, cuts were made where the cutting oxygen was specially pre-heated and others where it was left alone.

In the first comparative set, we have seven cuts without and eight with pre-heating. The material was open-heart steel plate 1.18 inches thick. The acetylene consumption was 8½ cubic feet per hour. The purity of the oxygen was 96.5 per cent; the pressure, about 29½ pounds per square inch. The results, with the oxygen not pre-heated, were as follows:

Length of cut in inches.	Time in seconds.	Time in minutes for 1 linear foot.
25.0	220	1.76
25.0	220	1.76
22.0	195	1.77
22.0	190	1.73
22.5	188	1.67
20.5	175	1.71
17.0	155	1.82
Average		1.75

With the oxygen pre-heated, the following results were obtained:

Length of cut in inches.	Time in seconds.	Time in minutes for 1 linear foot.
19.5	140	1.44
18.5	137	1.48
17.5	125	1.43
26.5	180	1.36
18.5	135	1.46
17.5	126	1.44
16.5	120	1.45
22.5	153	1.36
Average		1.43

We have here a saving of 0.32 minutes per foot by pre-heating—or 18 per cent. In the experiments, several other cuts were made both with and without preheating; but have omitter them as the cuts produced were not normal ones. The record gives the average oxygen consumptions for the individual cuts of the two classes—those involving unheated and those involving heated oxygen—which include these abnormal cuts.

SECOND SERIES OF TESTS.

The foregoing results are confirmed by a second series of experiments, the type of torch remaining the same. The thickness of the plate was here 0.37 inch. The oxygen pressure for these thin sheets was reduced to about 14.7 pounds per square inch. The acetylene pressure was such as to enable 1 foot to be cut with about 0.32 cubic feet of the gas. The purity of the oxygen was the same as before—96.5 per cent. The following table makes clear the results for the normal cuts, with "cold" oxygen:

Length of cut in inches.	Time in minutes.	Time in minutes for 1 linear foot.
39.4	2.42	0.74
39.4	2.75	0.84
39.4	2.67	0.81
39.4	2.67	0.81
39.4	2.50	0.76
39.4	2.42	0.74
39.4	2.58	0.79
39.4	2.42	0.74
39.4	2.33	0.71
Average		0.77

With the oxygen pre-heated, the results are as follows:

Length of cut in inches.	Time in minutes.	Time in minutes for 1 linear foot.
39.4	2.05	0.63
39.4	2.17	0.66
39.4	2.05	0.63
39.4	2.12	0.65
39.4	2.17	0.66
39.4	2.42	0.74
39.4	2.18	0.66
39.4	2.03	0.62
39.4	2.42	0.74
Average		0.67

The saving in time here amounts to 13 per cent. Omitting, as before, the cases of abnormal cuts and assuming the oxygen consumption to remain the same on the average, we have an oxygen consumption of 0.139 cubic feet per square inch of cut when the oxygen was not pre-heated, and of 0.118 cubic feet when the oxygen was pre-heated. That is, there was an actual saving of oxygen of 0.021 cubic feet per square inch of cut—or 15 per cent. It should be borne in mind that any saving of time means a saving of labor as well.

Quite a number of experiments have been tried where the object in view was to gain information regarding speed variations resulting from changes in the character of the heating part of the flame. Open-hearth steel having a thickness of 1.18 inches was used. The torch was an oxy-hydrogen instrument having the heating jet separated from the cutting jet. The oxygen was 99 per cent. pure. The oxygen pressure was about 22 pounds per square inch. The hydrogen and oxygen were kept pretty closely to the ratio 4:1, but the pressures were varied.

The results show that with low pressure the time required to effect the cutting was comparatively large. As the pressures were increased, the time required per linear unit of cut diminished. The best results seem to have been obtained when the pressures were rather heavy and where the relative amount of hydrogen fell off a little. With these cuts, the ratio of hydrogen and oxygen was in fact 15:4. The excellent results are, however, rather to be attributed to the heavy flame maintained. The five cuts were made not only more rapidly than with lesser pressures, but were apparently finer examples of cutting. The following table gives details:

Length of cut in inches.	Time in seconds.	Time in minutes for 1 linear foot.
41.3	270	1.26
41.3	270	1.26
32.7	215	1.31
31.5	185	1.17
29.5	202	1.37
Average		1.27

Another series of six cuts was made with the same size and type of torch, but upon heavier steel—that is, upon plate 2.56 inches thick. The oxygen was, however, only 96.5 per cent. pure. The oxygen pressure was about 29.5 pounds per square inch. The following table exhibits details:

Length of cut in inches.	Time in seconds.	Time in minutes for 1 linear foot.
6.7	75	2.24
6.7	70	2.09
6.7	72	2.15
6.7	65	1.94
6.7	70	2.09
6.7	90	2.69
Average		2.20

There results would seem to have been very good ones. The steel was more than twice as thick as in the preceding series of cuts and there must have been a greater proportionate loss in getting under way because of the short run of only 6.7 inches. The hydrogen-oxygen ratio in the heating flame was here 35:8—or something in excess of 4:1, the regulation ratio.

EFFECT OF PRESSURE OF CUTTING OXYGEN UPON SPEED

One further question remains to be considered. It is usual to employ a considerable pressure back of the cutting jet of oxygen. What advantage lies in a heavy pressure, and are there limits to the advantage, if such exists? These are important practical questions. Quite a number of experiments have been carried out whose results will help to their answer. In the following table, all except possibly the two lighter pressures represent groups of experiments. The average results are given. The oxygen used in these experiments was 99 per cent. pure. The plates were 1.18 inches thick. The torch was of the oxy-hydrogen type, and consumed in its heating jet 63.5 cubic feet of hydrogen per hour and 17 cubic feet of oxygen. It will be noted that this ratio 63.5:17 is a little short of 4:1. The tabular results follow:

Pressure of cutting. oxygen.	Length of cut in inches.	Time in seconds.	Time in minutes per linear foot of cut.
7.1	26.0	330	2.54
10.6	35.0	340	1.94
24.8	25.3	211	1.69
35.5	37.5	235	1.27
49.7	41.7	236	1.13

We see here that the speed of cutting increased steadily with the increase of pressure. However, the highest pressure produced a cut with the upper edge rounded. The pressure of 35.5 pounds seems to be about the proper maximum pressure to produce a perfect cut in the most rapid manner. It should be added that not only did the lower pressures correspond to slow cutting, but the work itself was faulty.—*Iron Trade Review.*

NOTES

There are over 7,000 miles of underground tunnels in the anthracite mines of Pennsylvania. The Philadelphia & Reading Coal & Iron Company has more than 800 miles of timbered gangways and drifts, and there is a total of 2,000 miles of these underground ways in the Schuylkill region alone.

The ideal race track of the world is undoubtedly at Salduro, Utah, 112 miles west of Salt Lake City, and here the world's speed record has been made. The track is a level crystallized salt bed 65 miles long and 8 miles wide, the salt 98 per cent. pure, and on this surface an automobile made a mile in 25.2 seconds, or 142.85 per hour.

The United States is by far the largest copper producer in the world; in fact, we produce more than all the rest of the world together. In 1845 the production was 224,000 pounds; in 1913 it was 1,224,484,098 pounds. The total production of the United States from 1850 to 1913 was 18,857,476,910 pounds.

The mine fire which has been burning at Summit Hill, Pa., for the last 62 years and which was believed to have been conquered, has broken out afresh. During the time that this fire has been in progress, coal worth millions of dollars has been burned, and great expense has been incurred by the Lehigh Coal & Navigation Co. in fighting it, with now no prospect of success.

A little known phase of the coal mining industry is the use of expensive barometers at the principal collieries of all the big companies, especially where the mines are gaseous. When the atmospheric pressure is decreasing gas is released more easily, and the fire bosses all look at the barometers before going into the mines to make their morning inspections. When the barometer is going down they look and test with extra care for gas.

The president of a large railway system says he could save $200 a car by buying freight cars now, which the railway can make good use of and will soon be in pressing need of. The inability or unwillingness of the directors to finance such a purchase will in all probabilty thus add 25 per cent. to the cost of the cars when they are finally ordered.—*Railway Review.*

The new French 4-inch gun for attack on aircraft has proved to be a very efficient weapon. It fires a projectile weighing about 36 pounds with a muzzle velocity of 1,870 feet per second. The sighting is by means of a panoramic glass and the gun-pointing is done similarly to that of the well-known French 75 gun. The carriage remains fixed, the gun recoiling to a distance of 1 meter and returning to battery by means of compressed air. The weight of the piece in action with its armored screen is about 2⅓ tons.

The New Zealand authorities, according to Commerce Reports, have placed an order with the Baldwin Locomotive Works for 10 locomotives of the first class, competitors for the contract being several English firms. The best English offer was that of the North British Company to complete 10 engines in 7 months at $23,262 each. The Baldwin offer was 10 engines in 60 days at $15,714 each.

In lowering a large steel storage tank to its foundation in a deep pit, Honolulu engineers built up a temporary resting place of blocks of ice, and then, after the structure had been properly centred, melted the ice uniformly with steam. The reservoir is 24 ft. in diameter, 25 ft. high, weighs 14 tons, and has a capacity of 80,000 gallons.

It seems that the purchaser of anthracite coal at any time owes a cumulative debt to the mine for the entire period of its future operation. It is computed that every ton of coal removed from the mines involves the removal of a ton of water every year thereafter. In 1904, in Pennsylvania anthracite mines, there were 846 pumps underground, and in 1914 there were 929 pumps, besides water hoists. Water delivered at the surface in these years was 446,120 and 489,600 gallons *per minute*, respectively.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 2.

1,126,732. VACUUM CLEANING-MACHINE. Ora Drake, Cleveland, Ohio.

1,126,799. FLUID-PRESSURE GENERATOR. John F. Lindberg, Hibbing, Minn.

1,126,831. MEANS FOR CONTROLLING THE INJECTION-AIR OF COMBUSTION-ENGINES. Jakob Muller, Winterthur, Switzerland.

1,126,865. DEVICE FOR AERATING LIQUIDS. Harry Vaughan Rudston Read, London, England.

1,126,890. PNEUMATIC HAMMER. John J. Sheehan, Roanoke, Va.

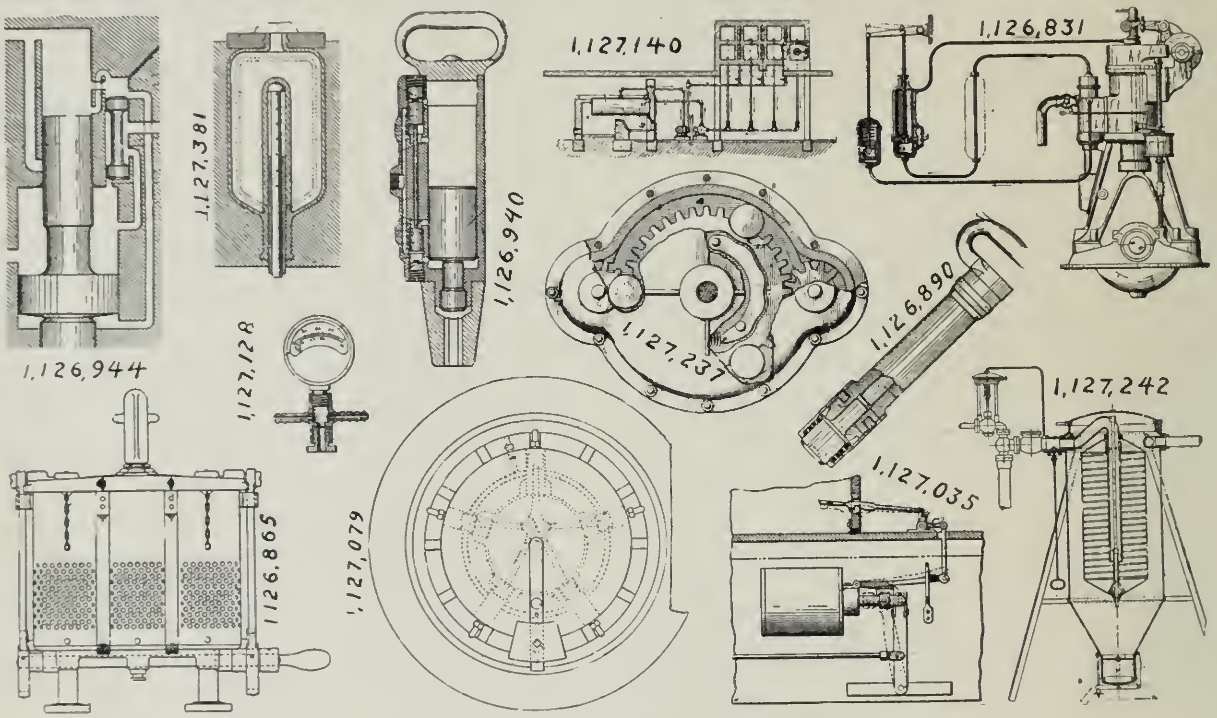
1,126,940. VALVE FOR PERCUSSIVE TOOLS. Lewis C. Bayles, Easton, Pa.

1,126,943-4. FLUID-OPERATED PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,127,035. BRAKE-LOCK. Andrew A. Linam, Purcell, Okla.

1,127,079. AIR-COMPRESSOR. Frederick Nielsen, Boston, Mass.

1. An air compressor comprising a cylinder, means for affixing the same to a wheel, a piston for co-operating with said cylinder to compress air, a crank connected to said piston to reciprocate the same, means carried by the wheel for affording a bearing for said crank parallel to the wheel axis, said crank being weighted so as to remain substantially in one position while the cylinder rotates with the wheel, and an air conduit for connecting the cylinder with a pneumatic tire on said wheel.



Pneumatic Patents February 2.

1,127,128. SAFETY PRESSURE DEVICE. William H. Walter, New York, N. Y.

1,127,140. APPARATUS FOR DESICCATING HUMAN CORPSES. Frank Wetterauer, Erie, Pa., and Gustave A. Wegner, Rochester, N. Y.

1. In a mausoleum, the combination of a vault the surrounding walls of which are made air-tight, an opening to said vault, an air-tight closure for said opening, a suction device operating to create a vacuum in said vault, means for operating the same, and pipe connections between said suction device and said vault substantially as and for the purpose described.

1,127,225. DUST-COLLECTOR FOR ROCK DRILLS. Emmet F. Galligan, Idaho Springs, Colo.

1,127,237. ROTARY FLUID-BRAKE. Charles R. Harris and Rutherford G. Goldman, Los Angeles, Cal.

1,127,242. APPARATUS EMPLOYED IN THE REMOVAL OF DUST AND THE LIKE. William George Hay, Prestwich, England.

1,127,381. METHOD OF FORMING GLASS VACUUM-RECEPTACLES. Clarence D. Byrnes, Sewickley, Pa.

FEBRUARY 9.

1,127,396. ROCK-DRILL. George R. Bennett, Denver, Colo.

1,127,419. APPARATUS FOR MODIFYING AIR. William A. Fairburn, Short Hills, N. J.

1,127,420. APPARATUS FOR DEHYDRATING AIR. William A. Fairburn, Short Hills, N. J.

1,127,726. FLUID - PRESSURE - OPERATED EJECTOR. William Buckley, Chicago, Ill.

1,127,823. RELIEF-VALVE FOR ROCK-DRILLS. Thomas E. Sturtevant, Dover, N. J.

1,127,826. AIR-BRAKE VALVE. George S. Switzer, Grand Rapids, Mich.

1,127,853. PROCESS OF AND APPARATUS FOR CRUSHING ORE. Hans Charles Behr, Scarsdale, N. Y.

1,127,896. DUST-COLLECTOR FOR VACUUM-CLEANERS. William H. Keller, Philadelphia, Pa.

1,128,014. VEHICLE AIR-SPRING. Richard Liebau, Swissvale, Pa.

1,128,058. METALLIC COATING AND PROCESS OF MAKING SAME. Max Ulrich Schoop, Hongg, near Zurich, Switzerland.

1. The process of metallically plating or coating articles, which comprises finely and uniformly subdividing a molten metal maintained under pressure, and projecting it upon the surface to be coated with sufficient force to produce a uniform, non-porous welded coating.

1,128,059. METHOD OF PLATING OR COATING WITH METALLIC COATINGS. Max Ulrich Schoop, Hongg, near Zurich, Switzerland.

1,128,207. COMBINED HYDRAULIC MOTOR AND VACUUM-NOZZLE. Nick E. Wilmes, San Francisco, Cal.

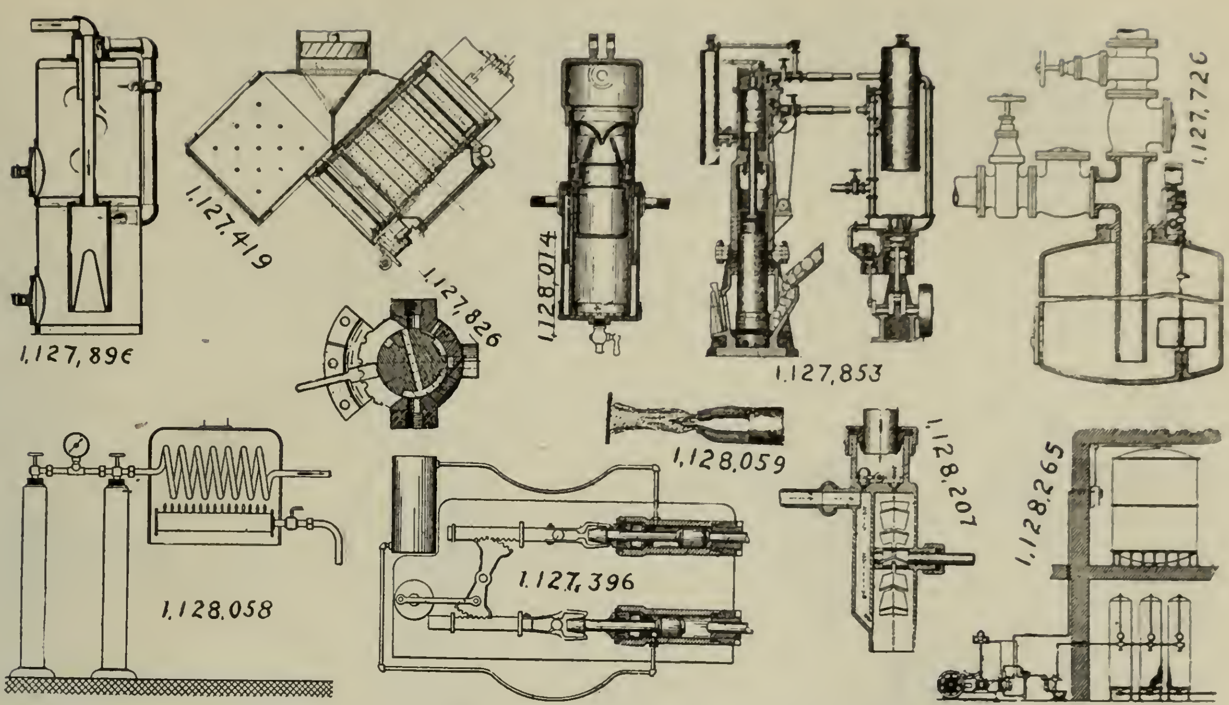
1,128,265. APPARATUS EMPLOYED FOR COMPRESSING FERMENTATION-GASES. Jacob F. Wittemann, Lakewood, N. J., and Rudolph W. Wittemann, Brooklyn, N. Y.

FEBRUARY 16.

1,128,416. PNEUMATIC HAMMER. Robert B. Crump, New York, N. Y.

1,128,428. MECHANICAL STOKER. Albert G. Elvin, Somerville, N. J.

1. In a mechanical stoker, the combination of a fuel receptacle adapted to be supported on a locomotive and to communicate with a firing opening in the firebox thereof, two fuel shovels mounted to swing horizontally in said receptacle, a fuel receiving hopper adapted to be supported on a locomotive tender below the fuel space thereof, a conveyer casing connected rigidly to



Pneumatic Patents February 9.

the fuel receptacle, and connected with the capacity of relative movement to the fuel receiving hopper, a plunger working in said conveyer casing, a fluid pressure motor actuating said plunger, and two fluid pressure motors, each actuating one of said shovels.

1,128,437. DUST-COLLECTOR FOR ROCK DRILLS. Emmet F. Galligan, Idaho Springs, Colo.

1,128,455. PRESSURE-CONTROLLER FOR TIRES. Edward B. Keith, Pontiac, Mich.

1,128,487. SUCTION CLEANING-TOOL. Richard H. Morrow, Waukegan, Ill.

1,128,574. MILKING-MACHINE. Gustaf Henrik Fabian Berglund, Stockholm, Sweden.

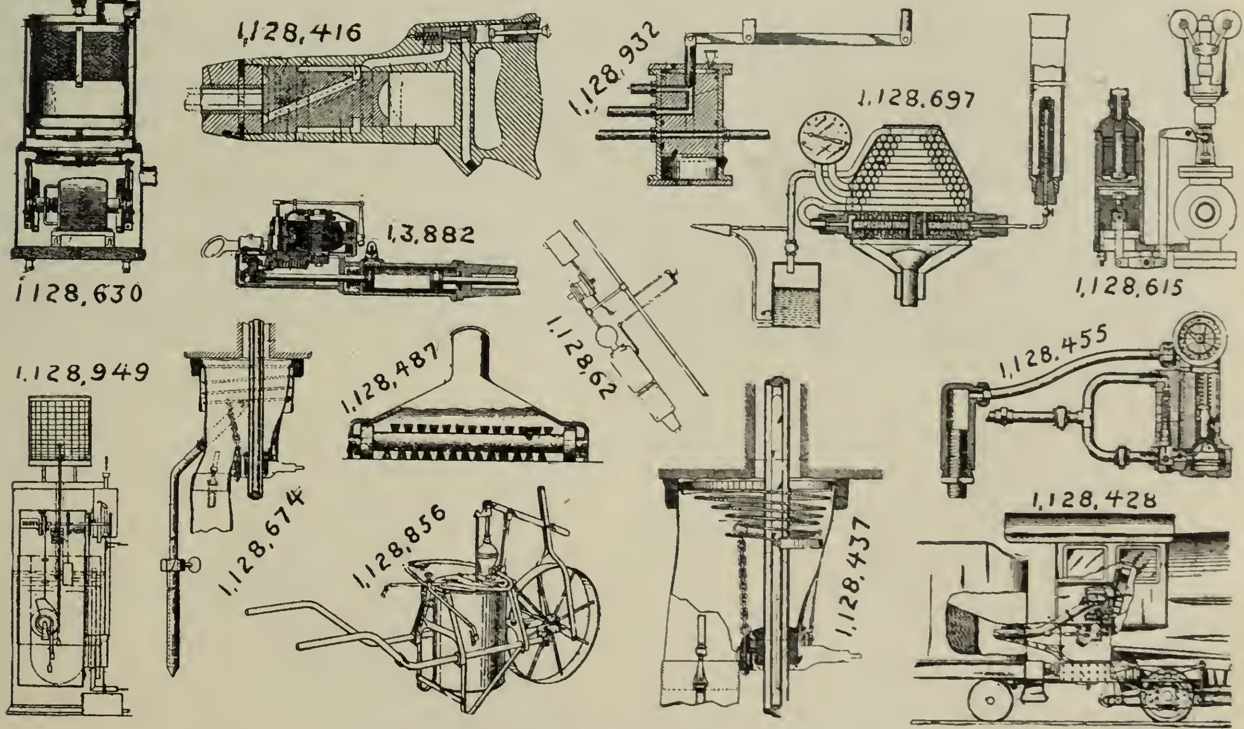
1,128,615. GOVERNOR FOR VACUUM CLEANING SYSTEMS. Augustus Lotz, San Francisco, Cal., and Clarence W. Bailey, Philadelphia, Pa.

1,128,622. QUICK-ACTION RELEASE MECHANISM FOR AIR-BRAKES. Spencer G. Neal, Los Angeles, Cal.

1,128,630. VACUUM-CLEANER. John W. Smith, Chicago, Ill.

1,128,674-5. DUST-COLLECTOR FOR ROCK-DRILLS. Emmet F. Galligan, Idaho Springs, Colo.

1,128,697. METHOD OF ATOMIZING LIQUID COMPOSITIONS SUCH AS PAINT. Fortunato Levy, Paris, France.



Pneumatic Patents February 16.

1,128,856. SPRAYING-MACHINE. Charles Cornwall and David J. Foltz, Salem, Ohio.

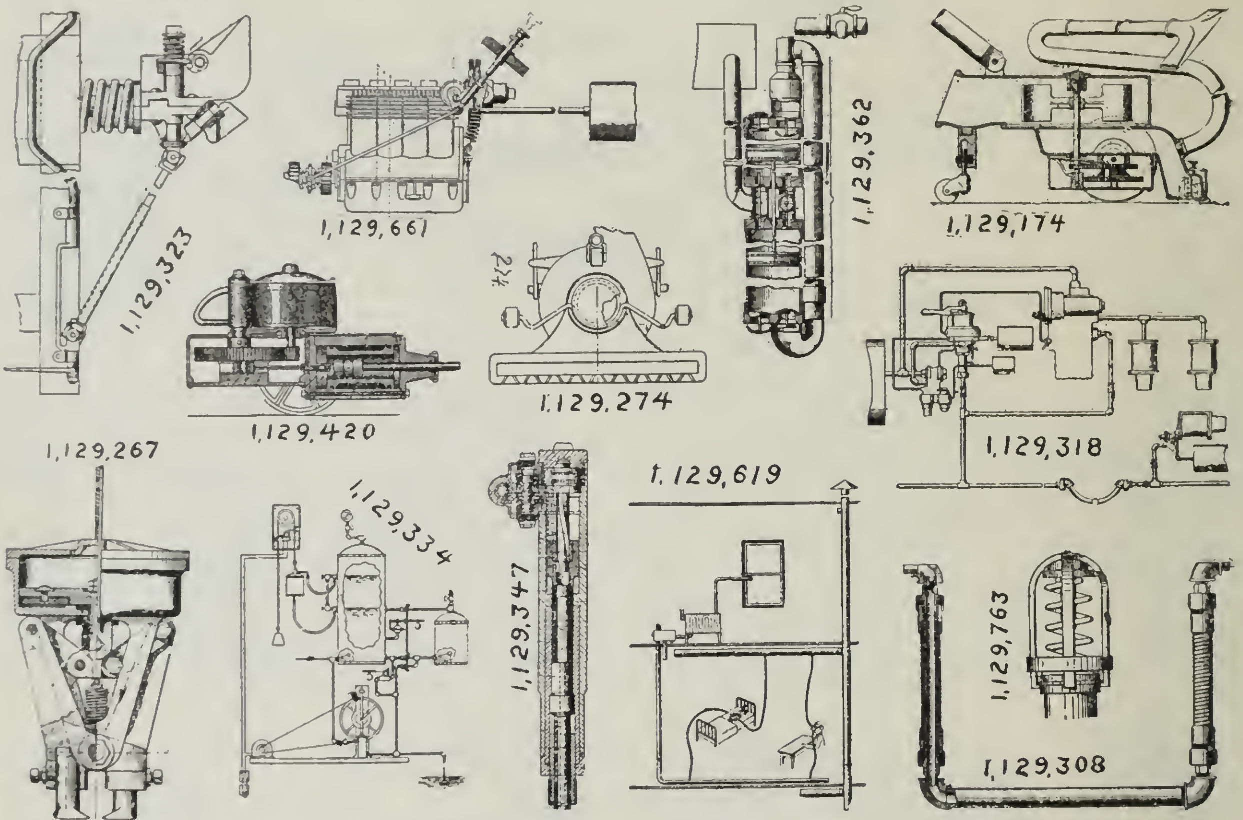
1,128,932. AUTOMATIC TRAIN-STOP. Frederick George Bastian, Buffalo, N. Y.

1,128,949. INSTRUMENT FOR MEASURING THE VELOCITY OF FLOW OF FLUIDS. Heinrich Contzen, Dusseldorf, Germany.

13,882. (Reissue.) PRESSURE-DRIVEN RECIPROCATING TOOL. Alexaner Palmros, Syracuse, N. Y.

FEBRUARY 23.

1,129,174. SUCTION-CLEANER. Matilda Dennis, Clifton Hill, Melbourne, Victoria, Australia.



Pneumatic Patents February 23.

1,129,267. PORTABLE PNEUMATIC STAYBOLT CUTTER. Archie M. Baird, Topeka, Kans.

1,129,268. AIR-TIGHT-SURFACE-FORMING COMPOUND. Henri Livingston Bates, Springfield, Mass.

A water proofing compound consisting of paraffin, one pound, spermaceti, two ounces, vaseline, three ounces, cottonseed oil, three ounces, powdered alum, two ounces, powdered rosin, two ounces and baking soda, one ounce, said paraffin, alum, rosin and soda together with the vaseline and cotton seed oil constituting a flexible filling for the openings in a piece of fabric, and also acting as a covering for the fabric to render the same air-proof.

1,129,274. VACUUM-CLEANER. George Clements, Chicago, Ill.

1,129,308. TRAIN-PIPE CONNECTION. Jesse C. Martin, Jr., San Francisco, Cal.

1,129,318-9. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.

1,129,323. COMBINED AUTOMATIC TRAIN-PIPE AND CAR COUPLING MECHANISM. George Westinghouse, Pittsburgh, Pa.

1,129,334. HYDROPNEUMATIC WATER SYSTEM. Owen C. Cover, Goshen, Ind.

1. In a hydro-pneumatic water system, a main service tank, an air supply tank, means for delivering water to said tanks, means for transferring the water from the air tank to the service tank to create a vacuum in and draw air into the air tank, and means for retransferring water from the service to the air tank to force the contained air from the latter into the former tank and to subsequently return the water from the air to the service tank, whereby the air in the service tank will be brought under compression.

1,129,347. FLUID-OPERATED DRILLING-MACHINE. Louis W. Greve, Cleveland, Ohio.

1,129,362. AUTOMATIC PNEUMATIC PUMP. Thomas E. Ryder, St. John, New Brunswick, Canada.

1,129,420. TOOL-ACTUATING DEVICE. Thomas Officer, Claremont, N. H.

1. In an apparatus for reciprocating an impact member such as a percussive tool or the like, the combination with a reciprocating driving element of an outer cylinder and an inner piston-cylinder movable within the same, a piston movable within said piston-cylinder, said piston and piston-cylinder constituting cooperating driving and driven parts connected one to the reciprocating driving element, and the other to the tool or other impact member, and means whereby the movement of the one causes a transference of fluid from outside of the piston-cylinder to within the same, and vice versa, such transference causing the consequent movement of the other member.

1,129,450. TIRE-PRESSURE GAGE. Robert A. Campbell, Minneapolis, Minn.

1,129,477. APPARATUS FOR CONDENSING AMMONIA FROM A GASEOUS TO A LIQUID STATE. Horace C. Gardner, Chicago, Ill.

1,129,619. INHALING SYSTEM. Gustave A. Zapf, New York, N. Y.

1,129,661. PNEUMATIC STARTER FOR INTERNAL-COMBUSTION ENGINES. George A. Gemmer, Detroit, Mich.

1,129,763. AIR-GOVERNOR. Charles Trojovsky, Norway, Iowa.

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

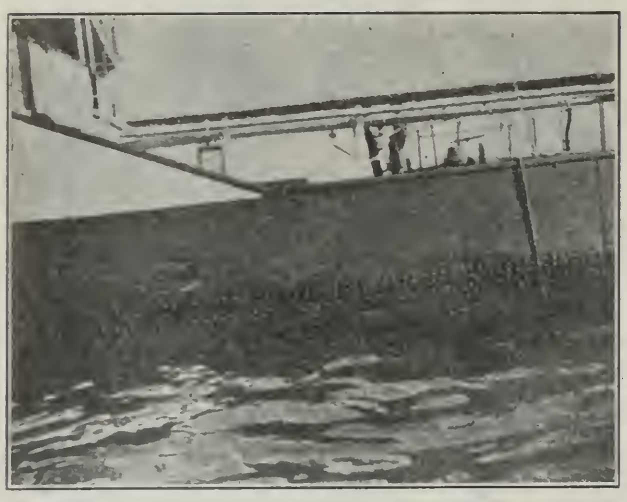
Vol. XX MAY, 1915 No. 5

KEPT AFLOAT BY THE TUG'S PUMPS.

COMPRESSED AIR SAVES ANOTHER SHIP

It is now quite well and generally known that no matter how big a hole may be stove in the bottom of a ship it can easily be kept afloat by compressed air if decks and bulkheads are approximately air tight. There comes to us through the pages of the Pacific Marine River an interesting account of the recent salving of an oil tank steamer, the Mina Brea, on the coast of Chile.

The tanker grounded on a shoal known as Lagarto Bank, about ten miles north of the northern extremity of Antofagasta Bay, while on a short trip between Tocopilla and Antofagasta. The latter port, by the way, is very close to the Tropic of Capricorn. The vessel entered the bay early in the morning with her siren going, calling for assistance. Tugs with high capacity pumps were sent off and moored alongside, and the water in the flood-



HOW LOW SHE SANK.

AS RAISED BY THE AIR.

ed compartments was kept down. Divers reported extensive damage to the bottom and after some of the lesser holes had been stopped the sailors erected an air compressor plant on the vessel's deck and she was quickly raised. Fig. 2 shows how little buoyancy there was left, the position of the deck being indicated by the line of rivets, and Fig. 3 shows how high she was raised by the air, the load of oil apparently having been discharged. Some further temporary repairs were effected on the bottom, a spare compressor was placed on board and the Mina Brea left for Talcahuano on October 23, arriving at that port on the 28th of the same month. This trip was made with a hole three and a half feet long and over two feet wide in the vessel's bottom, but the water was held back without difficulty by the air. After some repairs were effected the ship proceeded to San Francisco.

LAYING THE FLEXIBLE-JOINTED NARROWS SYPHON OF THE CATSKILL AQUEDUCT

BY STEPHEN W. SYMONS.

Among the great variety of engineering problems which have been involved in the construction of the great aqueduct which is to bring the pure water of the Catskills and distribute it in generous volume throughout Greater New York, not the least difficult and interesting is that which occurs near the end of the system, the laying of the siphon under the Narrows for the delivery of water in Staten Island.

This so-called syphon is a cast iron pipe, 36 in. in diameter, made in sections 12 ft. long, each of which weighs approximately 9,000 lbs. The total length of the syphon will be 10,000 ft. It is being laid in a trench 60 ft. deep and is covered with about 8 ft. of sand to guard against damage from the anchors of vessels. It was found necessary to flexibly couple the pipe, in order to permit of its being lowered from a lighter within a special steel lattice work, as well as to take up the inequalities of the trench. The joint employed is of the cast lead type, spherical in form, the bell end being turned on the interior, to a true sphere and highly finished with a band of steel shrunk on the outside. The spigot has deep grooves to retain the lead and a turned collar to bear in the bell. A sketch of the joint is shown in Fig. 1. It is in the caulking of this joint, after the lead has been poured, that the most interesting part of the work occurs.

Owing to the special form, it was found impractical to calk in the usual manner because of the necessity of deflecting the joint, both while laying the pipe and after it was laid, which would be almost certain to destroy the

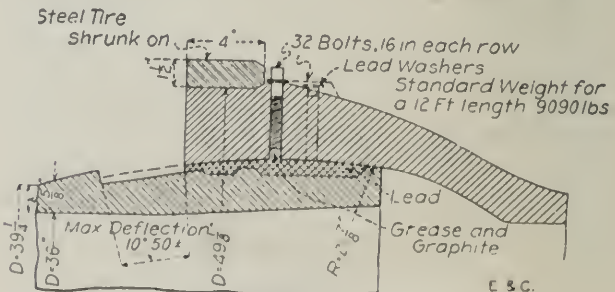


FIG. 1. ELEMENTS OF FLEXIBLE JOINT.

tightness of the caulking. Caulking the pipe from the bell end, after it was in position, would also have been both expensive and difficult, as well as insecure, owing to the very strong tides to be met with in that part of the Narrows and the added cost of retaining the services of a river. The joint eventually adopted was worked out from a suggestion made by a workman who had seen lead shot forced into small joints.

As can be seen from the sectional illustration, Fig. 1, a series of 32 holes, in two rows, were drilled and tapped around the periphery of the bell end of the pipe. After the joint has been poured full of hot lead, small pellets of cold lead were introduced and forced in by means of a screw plunger, as described later, to make up for the shrinkage of the lead in cooling.

METHODS OF LAYING PIPE.

The work is being carried on by the Merrit & Chapman Derrick & Wrecking Co. starting from the foot of 79th St., South Brooklyn, and crossing the Narrows to South Staten Island. Figure 2 shows the structural steel framework carrying the pipe, in place on the lighter "Comptroller." This framework extends down to the bottom of the channel and is curved so that the pipe, on leaving it, will lie flat in the trench. A pneumatic pontoon is attached at one end to supply a certain amount of buoyancy. The framework will accommodate 12 lengths of pipe. After the work has progressed further, the position of the pipe will be changed. Instead of coming over the lighter, as shown in Fig. 2, it will come up underneath it. The operation of laying the pipe is continuous, each section being hoisted to the top of the framework and lowered into place with the spigot end in the bell end of the previous pipe. The joint is then poured, caulked and tested and the lighter with the framework warped further out into the channel ready for the next length of pipe. The lighter is held by 10 anchors, each being supplied with 1,000 to 1,200 ft. of wire rope.

POURING THE JOINT.

A removable wooden staging is erected over

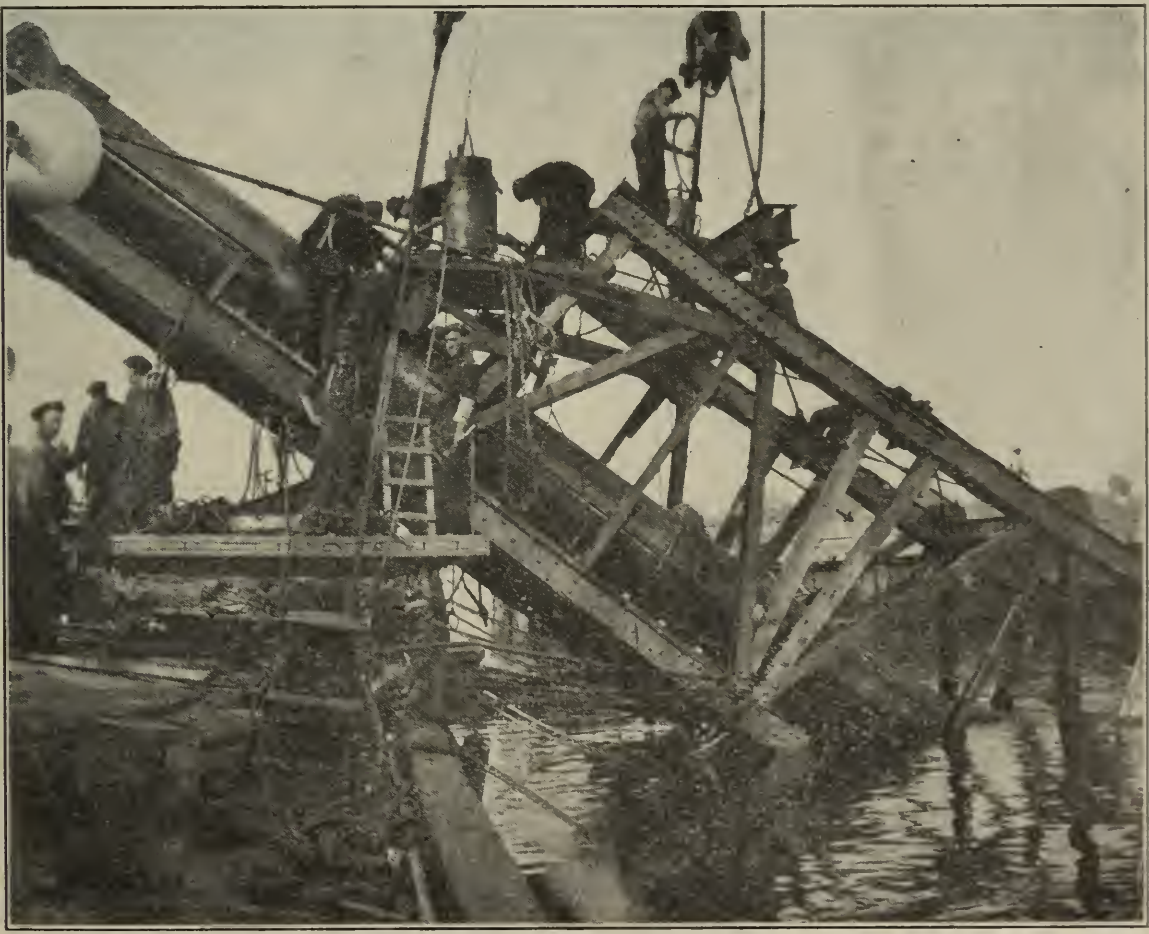


FIG. 2. PIPE, CRADLE AND WORKING STAGE.

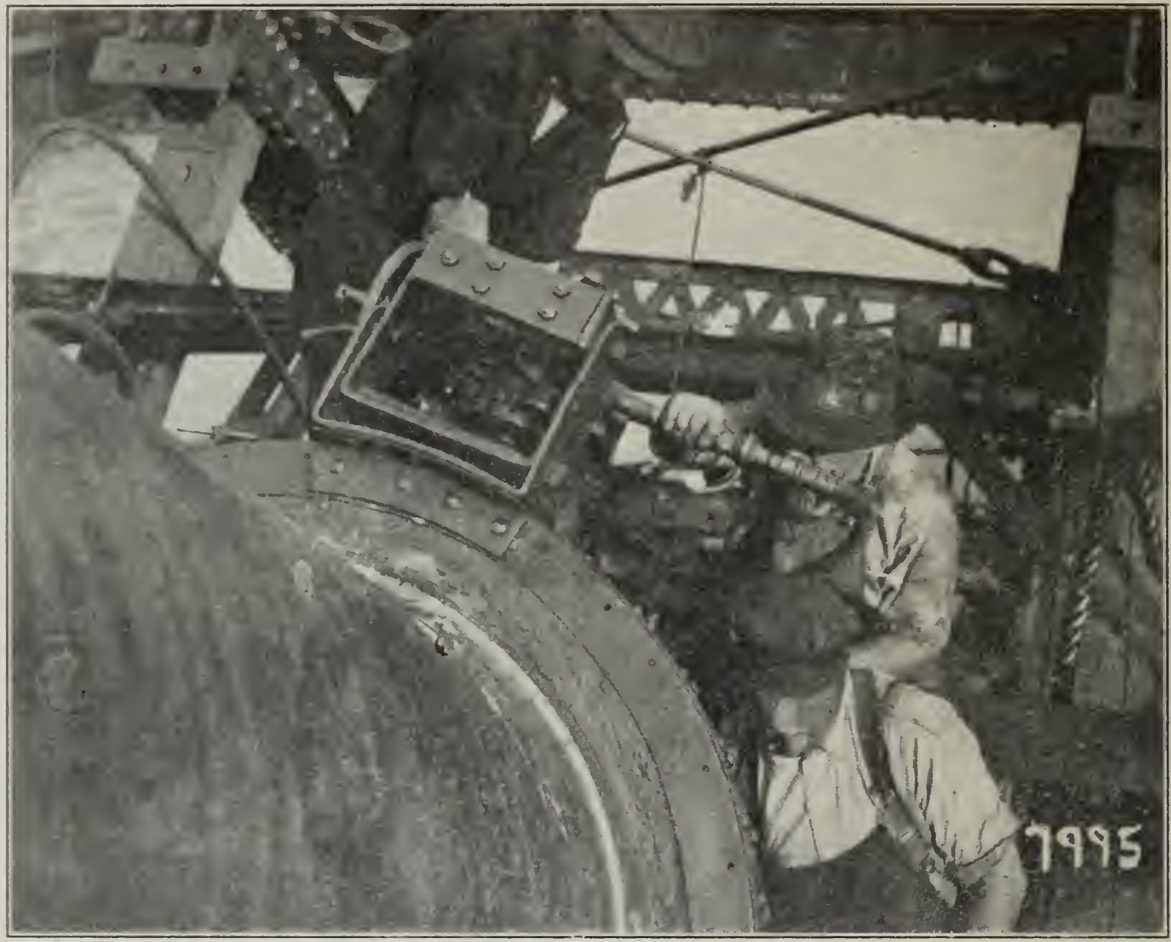


FIG. 3. SHOWING USE OF PNEUMATIC DRILLS.

the joint to accommodate the crew, melting pot and blow torch. The annular opening around the joint is first caulked with asbestos rope, held in place with a number of wooden chocks, bearing on the flange of the spigot. The arrangement of the staging can be clearly seen in Fig. 2. The discharge pipe from the melting pot is inserted in a fire clay mold at the top of the joint, everything is made fast, and the joint is ready.

The lead is heated by means of a gasoline torch operating under 80 lbs. air pressure. The lead is heated to 800° F., carefully tested for temperature and measured and the pot tapped. The total amount of lead for each joint is 350 lbs. Immediately after the joint is poured, the wooden chocks are knocked out, the melting pot is swung onto a hook conveniently placed near by, and the wooden platform removed, the whole operation taking about two hours from the time the pipe is placed in position.

CAULKING EQUIPMENT.

Pneumatic drills of the type ordinarily used for drilling metals and similar portable work, were adopted as the most reliable means for driving in the screw plugs. A saddle was rigged up of two semi-circular sections of angle iron to fit snugly over the steel band shrunk over the bell end of the pipe. This saddle carried four frames, each of which carries a drill. The drill frames allow of movement, in relation to the saddle, both longitudinaly and radially, this movement being controlled by means of a hand wheel on the dead handle of the drill for radial adjustment and, by means of a clamp and short groove, for the longitudinal adjustment. This longitudinal adjustment is necessary in order to swing the drill from one row of the holes to another. The frame holding the drill is pivoted at one end and provided with a long lever, by means of which it is fed to and from the work.

The drills used are of the angular four-cylinder type, fitted with square socket to accommodate the screw plugs. They are termed by their manufacturers, the Ingersoll-Rand Co., "No. 11 C." A system of compound gearing allows them a free spindle speed of 150 r. p. m. with great power; this being computed as about 995 ft.-lbs. per min. The drills are controlled both forward and reverse by turning the throttle handle. The air consumption is approximately 55 cu. ft. of free air per minute, but the operations are so intermittent that it is possible to use a compressor of a little less than half the aggregate capacity of the four drills running continuously, in connection with a receiver of large capacity. The compressor is an old style Rand machine. It is rated at 98 cu. ft. of free air at 140 r. p. m. The air pressure carried while the drills are in operation, varies from 80 to 60 lbs.

OPERATION OF CAULKING.

The drill frame is clamped over the end of the pipe, which is well greased to allow of its being rotated. Two men operate each drill. The holes in the row furthest from the end of the pipe are numbered consecutively 1, 2, 3, 4, the same numbers applying to the outside row of holes. The drills are adjusted over the holes numbered 1—the word is given and No. 1 plug is withdrawn, then Nos. 2, 3 and 4. A helper hands four pellets to each drill runner who inserts them in the holes with the screw plug on top of them. When all is ready the screws are run in and run out again, beginning with No. 1 and ending with No. 4 hole; the holes are again "loaded" and the operation repeated, this time from No. 4 to No. 1 hole, and so on until four pellets have been forced into each hole. A mixture of graphite and grease is then forced into each hole, in the same manner, and permanent screws of a different type fitted with soft lead washers are run in.

The second row of holes is handled in the same manner, except that sufficient graphite mixture is forced in to insure thorough lubrication of the entire surface of the joint. A noticeable expansion of the lead from the bell end can be seen, after the first row of plugs has been driven in. The methods of handling the drills can be seen in Fig. 3.

Driving the pellets into the row of holes farthest from the bell end first forces the lead to expand towards the bell end and further insures a thoroughly tight joint. Each pellet measures 9/16 in. x 1¾ ins. and weighs about 3 ozs., a total of 128 pellets, or approximately 24 lbs., being driven into each joint. The pressure within the joint is estimated at 22,000 lbs. The whole operation takes about half an hour, though the actual time for driving one set of four pellets and running the plugs out again averaged 30 seconds.

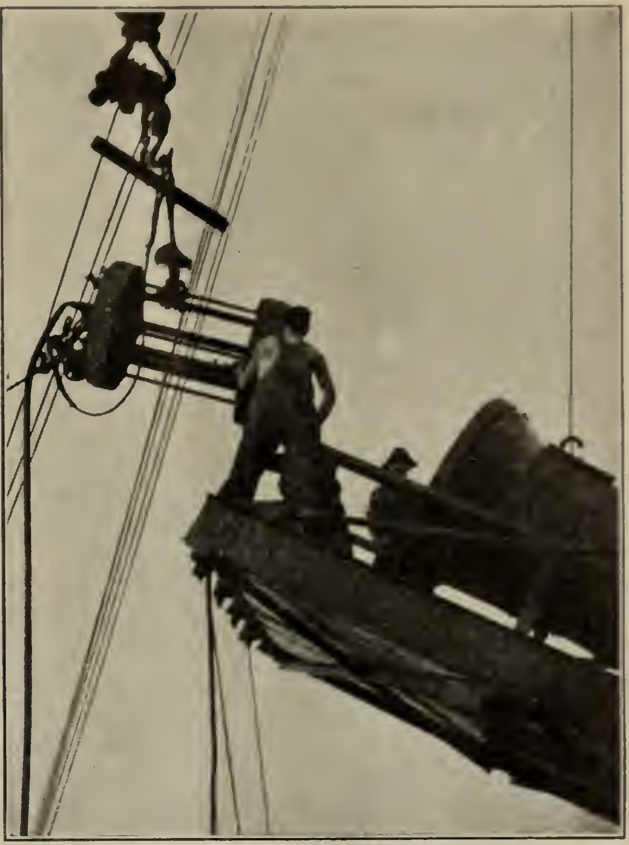


FIG. 4. APPARATUS FOR TESTING JOINT.

TESTING THE JOINT.

The joint is tested under the most severe conditions. The joint is first deflected to 5°, the maximum it is designed for being 10°. A testing machine is then lowered into place. This, as can be seen in Fig. 4, is composed of two diaphragms, held together by tie rods and provided with rubber cup leathers. One diaphragm is adjusted on each side of the joint and water under 100 lbs. pressure is introduced. No leakage has been recorded up to the time of the writer's visit, testifying to the thoroughness of the work and the practicability of this type of joint. The joint showed a smooth, well-greased surface where it was deflected. The total number of sections will amount to about 840. They are being laid at the rate of four a day, so that it will take the better part of a year to complete the work.

The contractors, the Merritt & Chapman Derrick & Wrecking Co., are handling this work in a highly efficient manner, as can be judged by the performance set forth in the foregoing

EXPLOSIVES—LOW, HIGH, SMOKELESS

An explosive may be defined as a solid body which under the influence of heat, or shock, resolves itself instantaneously into gaseous matter. Both chemical and physical forces come into play in this transformation. The solid constituents of the explosive mixture, on ignition or detonation, undergo chemical changes and become gaseous in character. The gas produced then expands under the influence of the great heat liberated by the chemical reaction, and requires many hundred times the volume, or space, taken up by the original solid matter from which it was generated. The completeness of this change determines the value of the explosive for military or other purposes.

Explosives may be divided into two classes known as "low" explosives and "high" explosives. In the "low" explosive the combustion is started by simple ignition, and spreads throughout the mass by the transfer of heat from layer to layer. The physical form of the explosive and the pressure, determine the rate at which the decomposition proceeds. The more finely divided the grains of powder, the more rapid is the combustion, and the art of preparing explosives for rifle- and gunfire consists in adapting the grades of powder to the work required. Black powder and the allied smokeless powders are low explosives.

"High" explosives require to be "detonated," and for this purpose a cartridge of mercury fulminate is generally employed. The decomposition of the explosive after detonation proceeds exceedingly rapidly in the form of an explosion wave. The explosives containing guncotton, nitro-glycerine, and nitrate of ammonia, are included in this class.

The original "black" powder, which may be regarded as the progenitor of all the later forms of explosive, consisted of charcoal, sulphur, and nitrate of potash. On firing this mixture, the nitrate of potash provided the oxygen necessary to convert the charcoal and sulphur into gaseous form, the nitrogen escaped free or in the form of an oxide, and only a slight deposit of potassium sulphide and sulphate remained behind to mark the place where the heap of black powder was ignited. The ordinary black powder contained 75 per cent. potassium nitrate, 15 per cent. charcoal, and 10 per cent. sulphur. Until a few years ago there were very slight differences to be found in the composition of the black powder used by the nations of Europe for military purposes; in fact, only slight changes had taken place in its composition or method of manufacture since it was first made by Bacon in the thirteenth century.

About forty years ago, the introduction of larger guns made it desirable to use an explosive that would be slower in its action, exercise less sudden pressure on the chamber of the gun, and continue the driving power up to the moment when the projectile left the muzzle. The "brown prismatic" powder was developed about this date, and gave much better results than the black powder previously employed for these large guns. The changed conditions governing the ignition of the charge were attained by using partially charred wood in place of charcoal, omitting the sulphur, and compressing the mixture before issue into large, dense prisms which ignited more slowly than a powder.

Both the brown and black powders, however, produced smoke, and the next step in advance was to invent a powder that, when fired, should be smokeless, and would not reveal the position of the gun. Vicille, a Frenchman, in 1884, succeeded in producing the first really smokeless powder from gelatinized nitro-cellulose, or "guncotton." This powder was introduced and known in the French Service as "Poudre B." Guncotton is made from cotton-waste, or cotton-wool, by treating it with a mixture of nitric and sulphuric acids. It is what chemists term a "substitution" product, that is, three atoms of hydrogen in cellulose are replaced by three groups of atoms, forming the NO_2 molecule. The chemical name for guncotton is, therefore, tri-nitro-cellulose, and its chemical constitution is represented by the formula, $C_{12}H_{14}O_{10}(ONO_2)_6$. Its advantages compared with ordinary black or brown gunpowder are: A greater explosive force, weight for weight; the products of combustion are entirely gaseous, therefore cannot foul the gun; it is non-explosive when wet, and can be safely transported and stored in this state; and, finally, it is smokeless or nearly so.

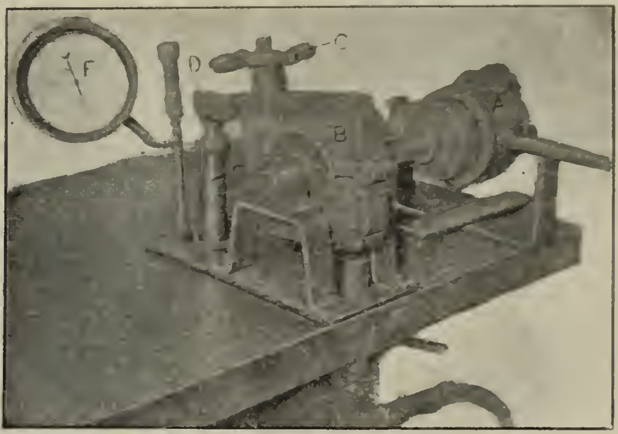
The British War-Office Chemist, Abel, made many improvements in the manufacture of tri-nitro-cellulose, and Nobel, by dissolving guncotton in nitro-glycerine, was the first to produce a hard horn-like material, which proved a safe form to handle.

"Cordite" is the form in which guncotton is employed for military and naval purposes in the United Kingdom, this name being due to its cord-like appearance in manufacture. Cordite is composed of nitro-glycerine, nitro-cellulose, and a mineral jelly. The effect of the two latter, when employed in conjunction with acetone, is to convert guncotton into a plastic substance that can be squeezed or rolled into any form desired, and that becomes hard and horn-like when dried. It can be cut into lengths, and handled or stored with perfect safety. When ignited it gives out great power, and exerts a uniform pressure in the chamber of the gun. Great accuracy has been attained in its manufacture, and its power can be modified to suit the requirements of the gun in which it is to be fired. For rifle fire the maximum pressure allowed is 20 tons per square inch,—for larger guns 19 tons per square inch.

Another group of new explosives have phenol (carbolic acid) as their base, and are known as "picric-acid" explosives. They are obtained from the action of nitric acid upon phenol, and by substituting, as in the manufacture of guncotton, the NO_2 group up atoms for the hydrogen atoms of the original compound. "Melinite" and "lyddite" are well known forms of picric-acid explosive used by the French and British military authorities.

The latest form of explosive for filling shells and torpedoes is, however, one of which toluol is the base, toluol being a methyl derivative of benzol. By the action of nitric acid upon toluol, substitution products containing three or four NO_2 groups can be obtained. It is now recognized that tri-nitro-toluol and tera-nitro-toluol are the best explosives for shells and torpedoes, since they do not act on the metal of the container like picric-acid explosives, and are quite stable under all conditions. All the countries involved in the present war are, therefore, using the nitro-toluol explosives in large quantities, and the demand for toluol, which is a derivative from tar, and, therefore, a by-product of coal distillation, is likely to be very keen as long as the war lasts.

"Tetra-nitro-aniline," another nitro-substitution product, derived from aniline, possesses most powerful explosive properties, and is doubtless now being employed by the Germans; while "ammonal," an explosive containing ammonium nitrate, aluminum powder and tri-nitro-toluol, has been employed by the Austrians in shells. "Turpenite" is another new explosive reported to have most deadly effects upon all forms of life. The composition of this explosive is not known, but, as it emits poisonous fumes, it is probable that cyanides (prussic acid is a cyanogen compound) enter into its composition. Turpenite has been tried experimentally by the French, but it was discontinued because its poisonous effects upon the air and soil are too deadly and too persistent. *J. B. C. Kershaw, in Engineering Magazine.*



MEASURING POWER OF AIR MOTOR.

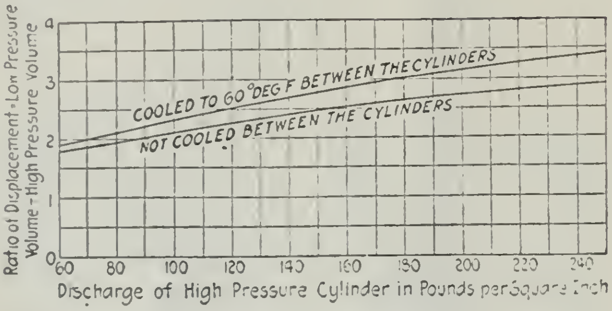
A PRONY BRAKE FOR TESTING AIR MOTORS

The halftone above shows a prony brake device in use in the C., R. T. & P. R. R. shop, Silvis, Ill., for testing air motors and described in the American Machinist by E. A. Thanton, Cincinnati. A is the motor being tested. It is coupled to the disk B which is clasped by the brake. The air is turned on and the brake blocks are tightened on the disk by turning the star-wheel C. The end of lever D rests on the plunger in the oil cylinder E, the pressure exerted on the oil is indicated by the gage F, and from the reading of the gage the torque of the motor and the actual power exerted are easily computed by the use of a constant multiplier in combination with the speed of rotation. With the evidence afforded by this device there can be no question as to the working condition of the tool to which it is applied.

CYLINDER RATIOS FOR AIR COMPRESSORS

BY F. W. SALMON.

Many steam-driven air compressors have to operate at speeds differing greatly from hour to hour to suit the demands for air. This makes it desirable to choose the cylinder ratios of the two-stage air ends with great care, so that the machine may operate steadily and smoothly without danger of stopping on a dead center even at the lowest speed, for naturally, a two-stage compressor will be chosen in most cases to secure economy in power for pressures of 80 lb. or higher, and in the case of large compressors, often for lower pressures.



The curves show the volumetric ratios required for a two-stage air compressor taking dry air at atmospheric pressure at sea level and delivering it from the high-pressure air cylinder at pressures of 60 to 250 lb. gage, both cooled and not cooled between the cylinders. Moreover, they are calculated to give the same power in the high-pressure cylinder as in the low-pressure.

In various books on compressed air, such as that by Frank Richards, Kent's "Mechanical Engineers' Pocket-Book," and Suplee's "Mechanical Engineers' Reference Book," are given tables showing the horsepower required (neglecting friction) to compress and deliver one cubic foot of free dry air per minute at atmospheric pressure, to given discharge pressures, both isothermally (perfectly cooled between the cylinders and during the compression) and adiabatically (not cooled at all). This given horse-power has been divided equally between the two cylinders and the mean effective pressures calculated for each, as well as the resulting intercooler pressure, which may be taken as the initial pressure for the high-pressure cylinder. Hence the volumetric displacement to meet these conditions could be readily calculated for several of the pressures given, including the 60-lb. and the 250-lb., and a smooth curve drawn through the points so obtained on the chart. This covers the range of pressures needed in over 95 per cent. of the air compressors sold, and it can be read close enough for all ordinary work, because in commercial practice air compressors are rarely made to bores of fractions of an inch.

Practically all air compressors operate between the limits shown by the two curves. Even in a single-stage compressor, the air is cooled somewhat during compression, and yet in the best two-stage machine it is never quite as perfect as isothermal compression; hence in practice it is wise to choose the nearest commercial cylinder sizes that fall between the curves shown in the chart. Of course, one should consider the actual volume of air displaced from each cylinder rather than the piston displacement, as the cylinder ratio depends upon the volumetric efficiency of each cylinder, which is rarely the same for both the high- and the low-pressure cylinders. This is illustrated in the following example:

Assume, that in order to deliver the air required, a 24-in. low-pressure cylinder will be used having a 30-in. stroke and giving a volumetric efficiency of 0.90 for this stroke with the type of valves used. The size of the high-pressure cylinder is desired that will discharge air at 100 lb. gage, with the same stroke, but with a different type of valve which will probably give a volumetric efficiency of 0.85.

Running up the 100-lb. line the best cylinder ratios are found to be 2.11 not cooled or 2.30 cooled. As both cylinders are to have the same stroke, only the areas have to be considered; hence, if A represents the area of the low-pressure piston in square inches and a the area of the high-pressure piston in square inches, then,

$$a = \frac{A \times 0.90}{\mathit{constant} \times 0.85}$$

or

$$a = \frac{452.4 \times 0.90}{2.30 \times 0.85} = 208 \textit{ sq. in.};$$

say 16¼ in. diameter (if fully cooled), and

$$a = \frac{452.4 \times 0.90}{2.11 \times 0.85} = 227 \textit{ sq. in.};$$

say 17 in. diameter (if not cooled).

Thus, there is not much difference, and as explained above, actual practice will lie between these **two curves.**

[The above article, reprinted from the pages of *Power,* our readers may take for what it may be worth. Why there should be any computations having to do with two-stage compression without intercooling is not quite obvious, since to provide the opportunity for the intercooling is the only practical reason for the two-stage arrangements. Ed. C. A. M.].

BREAKING ROCK FOR STEAM SHOVELS.

BREAKING UP ROCK FOR STEAM SHOVELS

BY CHARLES C. PHELPS.

When a steam shovel encounters chunks of very soft rock that are too large to enter the bucket, the simplest means of disposing of them is often by sledging and sometimes by dropping them upon another rock. If the rock is of harder nature, however, blasting must be resorted to. In rock excavation work, the material may be shattered to such an extent that all subsequent breaking will be unnecessary. if the blast holes are spaced sufficiently close and if relatively heavy charges of explosives are employed. This procedure will, however, so greatly increase the cost of operations as usually to make it prohibitive. The plan generally adopted, therefore, is to drill so that the bulk of the material will enter the jaws of the bucket and then employ a gang of men to go ahead of the steam shovel and break up all the rock that is oversize.

Generally speaking, there are two ways of blasting such boulders, i. e., by applying surface blasts to the rock and by exploding charges in shallow holes drilled in the rock, the latter being known as pop-shooting or block-holing. In surface blasting, a stick of dynamite is placed against the rock and, after being properly wired up, it is covered with a "mud-cap," "plaster," or "dobie" of mud or mortar. Naturally the breaking effect by this method is much less than with a charge in the body of the boulder, and the cost of powder for blasting a rock of any size in this way is very much more than for pop-shooting.

Four ways of accomplishing block-hole drilling are open to the contractor or quarryman, namely: (1) With sledges and hand steels; (2) With mounted tripod drills; (3) With non-rotating plug drills operating with compressed air, and (4) With steam or air operated hand drills of the self-rotating type.

The last type operates satisfactorily on steam as well as on compressed air. Formerly plug drills were not constructed to employ any other power than compressed air, therefore the development of the steam type has greatly broadened the field of the hand drill, one of the most important applications being its use as an adjunct to a steam shovel.

In order to compare the relative advantages of the four methods, we will consider an average case where the rock is a very hard limestone and where it is necessary to drill pop-holes averaging 12 ins. in depth. The holes put in by tripod drills would probably be a little over 2 ins. in diameter and those made by the first, third and fourth methods would probably be under 2 ins. in diameter, but this difference can be left out of consideration because the smaller holes would be amply large for their purpose. The cost of sharpening steels can also be left out of consideration, for this would be nearly the same per foot of hole in all four cases. The wages for drill operators range from $1.50 to $4 per shift in various parts of the country and from $1.50 to $3 per shift for helpers. We will therefore use in our calculations the average wage of $2.75 for drill runners and $2.25 for helpers per eight-hour shift.

A medium size piston drill will require about 125 cu. ft. of free air per minute at 90 lbs. pressure, or if operating on steam will require about eight boiler horsepower at a corresponding pressure. Both of the small types of hand drills will require less than half of this amount of power. In the most advanced type of oil-engine driven air compressor, air can be compressed to this pressure for a fuel cost of about 4 cts. per 1,000 cu. ft., with kerosene at 8 cts. per gallon. The cost of steam at this pressure would be about 9/10 cts. per boiler horsepower per hour with coal at about $3 per ton, assuming 6 lbs. of coal required per hour per boiler horsepower.

The cutting speeds referred to below are only approximate, being based on a large number of actual cases that have come to the attention of the writer. The cutting speed of five minutes per foot has been applied to cases two, three and four to be on the safe side in estimating, although a slightly better speed should be attained in case three and a still greater speed should result in case four, for reasons to be explained later.

Comparing the accompanying estimates of cost, it appears that drilling with sledge and steel is extravagantly expensive. Drilling with mounted drills is also very expensive for this class of work, due mainly to the fact that more time is consumed in setting up the drill than in actual cutting. The choice of equipment would, therefore, seem to lie between the two types of hand drills. The difference in cost of operation between the two latter types does not appear to be so great from the above estimate, but there are other considerations of equal importance which point to the automatically rotated hand hammer drill as the ideal type for steam shovel work. In the first place it operates on steam taken directly from the boiler of the steam shovel, whereas the ordinary plug drill is adapted for operation on air only. This eliminates the initial and upkeep cost of a compressor mounted on the

DRILLING WITH SLEDGE AND STEEL.

Labor cast per shift, 1 drill man	$2.75
Labor cost per shift, 2 sledge men	4.50
Total	$7.25
Time required to cut 12-in. hole, about, minutes	15.0
Cost per 12-in. hole	$0.227

DRILLING WITH MOUNTED PISTON DRILLS.

Labor cost per shift, 1 driller	$2.75
Labor cost per shift, 1 helper	2.25
Total	$5.00
Cost for steam (assuming drill in actual operation during 2/5 of shift)	0.23
Cost for labor and steam per shift	$5 23
Cost for air (assuming drill in actual operation during 2/5 of shift)	$0.96
Time required to cut 12-in. hole, about, minutes	5.0
Time required to move drill from previous setting and to adjust (5 to 10 minutes), average, minutes	7.5
Total per hole, minutes	12.5
Labor and steam cost per 12-in. hole	$0.136

DRILLING WITH ORDINARY PLUG DRILLS.

Labor cost per shift, 1 driller	$2.75
Cost for air (assuming drill in actual operation during 5/6 of shift and air consumption ½ of mounted drills)	1.00
Cost for labor and air per shift	$3.75
Time required to cut 12-in. hole, about, minutes	5.0
Time required to shift and for small delays, minutes	1.0
Total per hole, minutes	6.0
Labor and air cost per 12-in. hole	$0.047

DRILLING WITH AUTOMATICALLY ROTATED HAND HAMMER DRILLS.

Labor cost per shift, 1 driller	$2 75
Cost for steam (assuming drill in actual operation 10/11 of shift and steam consumption ½ of mounted drills)	0.26
Cost for labor and steam per shift	$3.01
Time required to cut 12-in. hole, about, minutes	5.0
Time required to shift position, minutes	0.5
Total per hole, minutes	5.5
Labor and steam cost per 12-in. hole	$0.035

steam shovel boiler or a separate compressing plant and any charges that there might be for attendance to such a unit. This one consideration has been the determining factor in a large number of cases where the automatically rotated hand type has been adopted for drilling pop-holes in connection with steam shovel excavation. Another important advantage of the latter type is the fact that the hole is quickly started and the steel is scarcely ever known to stick due to the positive rotation mechanism. On the contrary, ordinary plug drills frequently cause trouble and delay in these respects, especially when they are operated by inexperienced workmen, and the amount of muscular energy required to rotate a plug drill back and forth soon tires the operator, so that he is incapable of keeping up to the pace which we have adopted as our standard.

The drill in the halftone has an 18-in. piece of ¾-in. pipe screwed into the exhaust to carry the steam away from the operator, and wooden handles are fitted to the machine, so the drill is perfectly comfortable to handle. In this case there is a 60-ft. length of hose and the boiler pressure gage registers about 110 lbs. In other cases the drill operates as far as 400 or 500 ft. away from the shovel. In such cases poorer results are to be expected, especially in cold weather, due to the condensation of the steam in the line, even when it is covered with insulating material. The steam operated drill may be used for cutting either wet or dry holes. In the latter case hollow drill steel is often employed, together with a special type of throttle valve on the exhaust which can direct the steam through the steel at the will of the operator to blow the cuttings out of the bottom of the hole. It is customary to use a slightly smaller piston with a drill operating on steam in order to allow for the expansion. Likewise only the best quality of steam hose should be used for conveying the steam to the drill. Proper lubrication is of even greater importance when operating with steam than when using air and a heavier oil should be used with a steam drill than with one using air. It will pay to remove the steel from the chuck occasionally and squirt a few drops of oil on the bottom of the piston. This, in addition to the regular automatic lubrication, will result in a drill of this type operating practically as well with steam as with air.

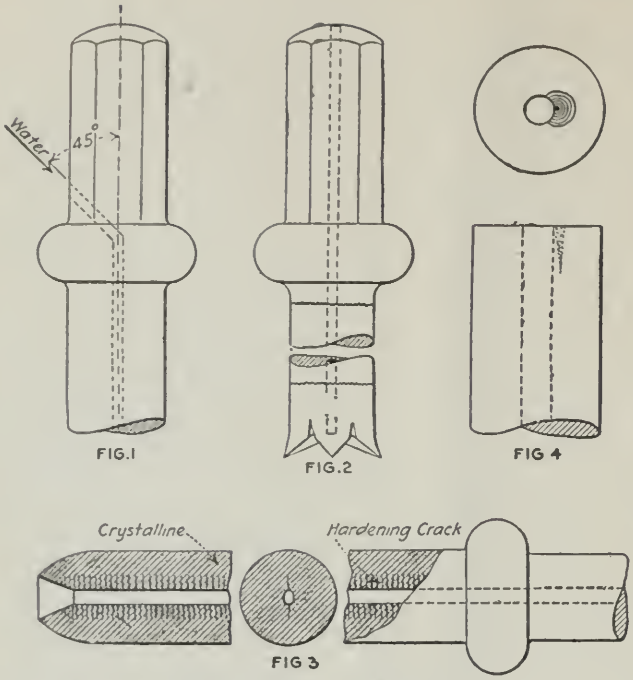
These little machines use the hammer principle and operate at a very high speed, perhaps 1,000 blows per minute or more.

An interesting and puzzling case occurred recently in which drills of the self-rotating hand hammer type were condemned by a quarry superintendent because the steels were constantly getting stuck. The rock was a rather soft limestone and a six-point drill bit was used. The drill was examined for defects but none were found. Then four-point bits were substituted and that helped matters a little, but the trouble continued. The bits were then removed and flattened on the bottom until they were quite blunt, which resulted in ending the difficulty. The trouble had been due to the pointed bits cutting so fast that they would soon become embedded in the cuttings, preventing the rotation of the steel and, of course, interfering with the action of the piston. This case is mentioned simply to show that, in applying this novel type of drill, difficulties may be encountered under unusual conditions, but the exercise of a little ingenuity in adapting the machine to the conditions will generally overcome them easily.

The new type has become popular with the drill runners, because they are so much easier to handle. In many cases their adoption has resulted in increased earnings for the men. In one notable instance, where hundreds are in operation, the drill runners are earning nearly 20 per cent. more in wages while the profits of the owners are increasing correspondingly due to increased production and lower operating costs.

DEEPER DRILLING GETS THE GAS

By drilling abandoned gas wells deeper the Wyckoff Oil and Gas Co. has struck a number of paying gas wells near Kane, Pa. Three wells, one registering 5,000,000 feet, another registering 1,500,000 feet and the third registering 1,000,000 feet have been harvested by the company quite recently. During the last year a number of wells were drilled to a depth of 1,600 feet without success. These wells were leased by the Wyckoff company and drilled to a depth of 2,600 feet with wonderful results. As a result of this successful venture other companies are taking up leases. The field was regarded as a failure a year ago, when 60 gas wells were drilled with unyielding results.



DRILL STEEL EXAMPLES.

FAILURE AND HEAT TREATMENT OF DRILL STEEL

BY SVEN V. BERGH.

The development of the hammer-drill machine during the past decade has brought with it high requirements for the drill steel. As a consequence, the steel has from time to time been much improved. However, to use to the best advantage the steel at present on the market, it should be selected with regard to the work to be done, and the right treatment should be applied when the steel bars are made into drills.

The steel generally used for rock drilling may be classified as carbon steel; hence the degree of hardness means the percentage of carbon contained. Experience has proved that the proper percentage of carbon is governed chiefly by the hardness of the rock to be drilled and by the power of the machine. E. Odelberg says in *Jernkontorets Annaler,* 1912, that he seldom found among mining men a right understanding of the fact that the harder the rock, the softer must be the steel. This is due to the fact that the bit will not stand the impact if too hard a steel is used to penetrate hard ground, the degree of hardening necessary to improve the wearing qualities of the bit depending upon the conditions under which it has to be used. The above rule must also be applied when a heavier type of drill is being substituted for a lighter one and the steel does not seem to stand up well. The ultimate carbon hardness being already reached, a softer steel must be tried.

In some drilling practice, as, for instance, when hand-feed drills are used, bending stresses are likely to be put on the steel. Additional tensile and compressive stresses are thus induced during the period of the blow, producing an excessive strain in the steel. In such practice a heavy size of steel is to be recommended.

When the steel is shanked it is of importance to give the shank sufficient length and cross-sectional area. It happens not infrequently in mining fields, where a light type of drill has been substituted for a heavier one, that the old steel is continued in use. This is not advisable, for the additional reason that it necessitates a considerable change in the front head of the machine. The inconvenience of such a practice is shown by tests in the following table taken from my article in the *Journal,* September 26, 1914, p. 560.

EFFECTS OF NEW AND OLD CHUCK BUSHINGS ON DRILLING SPEEDS OF INGERSOLL M. C. 32 DRILL.

Air Pressure Gage, Lb. per Sq. In.	Net Time of Run, Minutes	Depth Drilled, Inches	Front Head Bushing
78	3	14.6	New
78	3	12.2	Old

The number of ruptures may sometimes be greatly reduced by giving the shank a greater cross-sectional area. In 1911, tests were carried out at a mine in Sweden to find the effect of such a change. The rock at this particular mine is exceedingly hard to drill, as it consists of quartz-striped magnetite and hematite ore with leptite as a country rock. During a three-month period one and the same type of drill was used. The following results were obtained: Ordinary shanks ruptured, 185, corresponding to 6277 m. drilled; strengthened shanks ruptured, four (171 used in all), corresponding to 700 m. drilled. These figures show a considerable improvement following the use of the heavier shanks. Here it may also be mentioned that all abrupt changes in section and sharp corners should be strictly avoided.

So far as water-using drills are concerned, when the water is fed into the steel through a radial boring it has proved an advantage to drill the hole at an angle of 45° with the center hole of the steel, Fig. 1.

To shape the shank and the bit, the steel has to be upset at both ends. This operation changes the internal structure of the steel unfavorably, at the same time producing in some parts of it the bad effect of "cold work," due to the manner of applying the heat. Ruptures as shown in Fig. 2 are frequently seen. Thus to utilize the best properties of the steel it is necessary that the upsetting be performed in such a way that the steel receives the proper heat treatment. From this it may be understood why it is regarded good practice to forge and harden the bit in separate heats.

To obtain the finest grain, the bit has to be forged continuously from the highest temperature employed down to the finishing temperature, which probably is slightly above the point of recalescence. It is advantageous in hardening not to treat it to any higher temperature than necessary. The steel is liable, if heated too high, to change into a coarse crystallization and develop hardening cracks that may cause ruptures.

The shank must always be tempered properly after being hardened. Some good hints on this point are found in an article entitled "Hammerdrill Shanks," Compressed Air Magazine, October, 1914.

Finally, it may be mentioned that shanks sometimes rupture longitudinally, Fig. 3. Some cases that were investigated showed that the failure was due to careless straightening after the steel had been upset. The center hole of the shank was thus oval instead of round and this later caused it to rupture when the steel was used.

Two kinds of rupture may be distinguished, namely: (1) ruptures that appear as developed from a coarse-grained structure and (2) ruptures that evidently have developed from a partial break or inclosure in the steel. In regard to ruptures of the first class mentioned, the opinion frequently heard among users of drill steel is that the crystalline texture often found is due to vibrations. It is not my intention here to discuss whether such an opinion is wrong or not, but to call attention to the fact that the crystalline texture might have been caused during the manufacture of the steel bars by wrong or insufficient heat treatment. The crystallized steel is sometimes hard to restore completely. By annealing, the crystals may only be more or less broken up, still maintaining their previous orientation. Thus cleavage planes are developed along which ruptures occur, giving the appearance of a crystalline fracture, although the steel in reality is fine-grained.

The typical fracture of the second class is as follows: A circular or oblong cavity or a crack is found at some part of a transverse section. This cavity or crack is surrounded by concentric rings covering a certain portion of the section, the rest being more or less covered by an ordinary crystalline fracture, Fig. 4. Mr. Catlin, of Franklin Furnace, called attention to ruptures of this kind at a meeting of the New York section of the Mining and Metallurgical Society of America, in January, 1914. He stated that according to his experience these inclosures seemed to run through the whole length of the steel and if it was broken anywhere, one could expect to find them. I am also able to state from my own investigations that this kind of rupture occurs rather often.

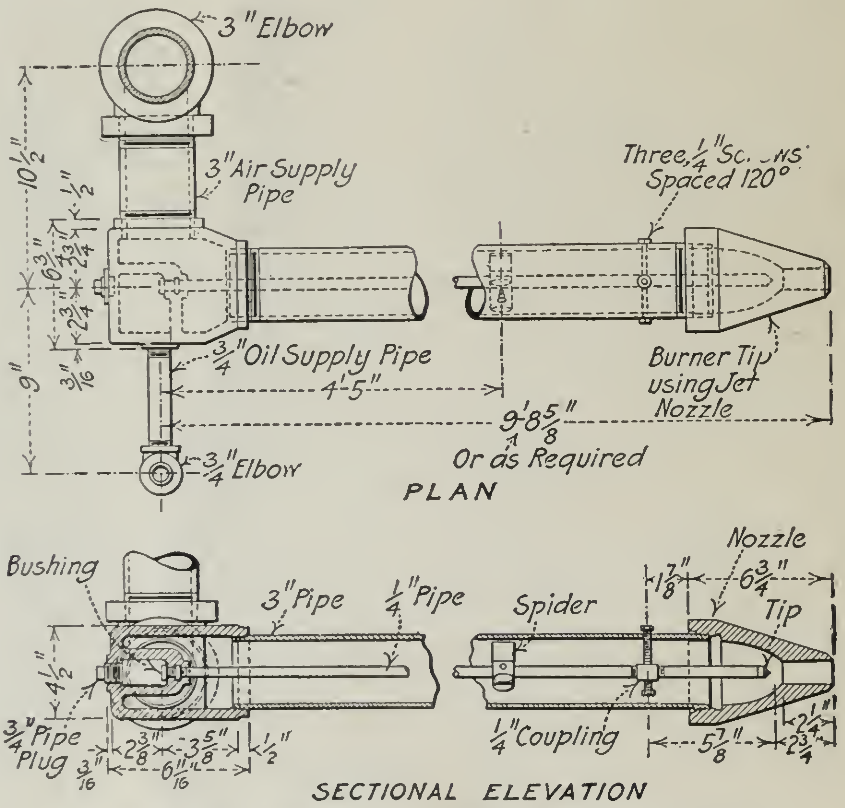
Similar ruptures are often found in connection with broken rails. Two interesting articles recently published upon this subject are to be found, one in *Iron Age*, Feb. 19, 1914, and one in the *Railway Age Gazette*, Feb. 6, 1914.

It is of practical importance to determine whether the inclosure mentioned consist of slag or of sulphide of manganese, the latter usually occuring in the form of round drops, which, if large in size, may be elongated by the rolling. Sulphide of manganese is best recognized by etching the surface of the fracture with a mixture of dilute hydrochloric acid and bichloride of mercury, when the sulphur appears as dark spots. A print also may be taken conveniently by exposing the fracture for four or five minutes to a piece of silk wet with the solution.

It may be of interest to many to hear that ruptures have also been found to start from groove marks on the steel, where numerals or other marks have been stamped by the drill runner.

It is evident from what is now said that the annealing of the drill steel at intervals will mean only a partial improvement. Internal strains produced by cold working of the metal and coarse-grained crystals may be effaced, but there is no possibility of eliminating ruptures of the second class metal. This is in accord with what has been found at various Swedish mining fields where the practice is to anneal drills every second month.

So far as the steel problem is concerned, the structure of steel exposed to vibrations has proved to be of utmost importance. The carbitic structure has been found to stand up best. It is obtained either by cooling the steel quickly through the so-called critical range without actual quenching, or by rapid cooling and then reheating to about 600° C. *Eng. & Min. Journal.*

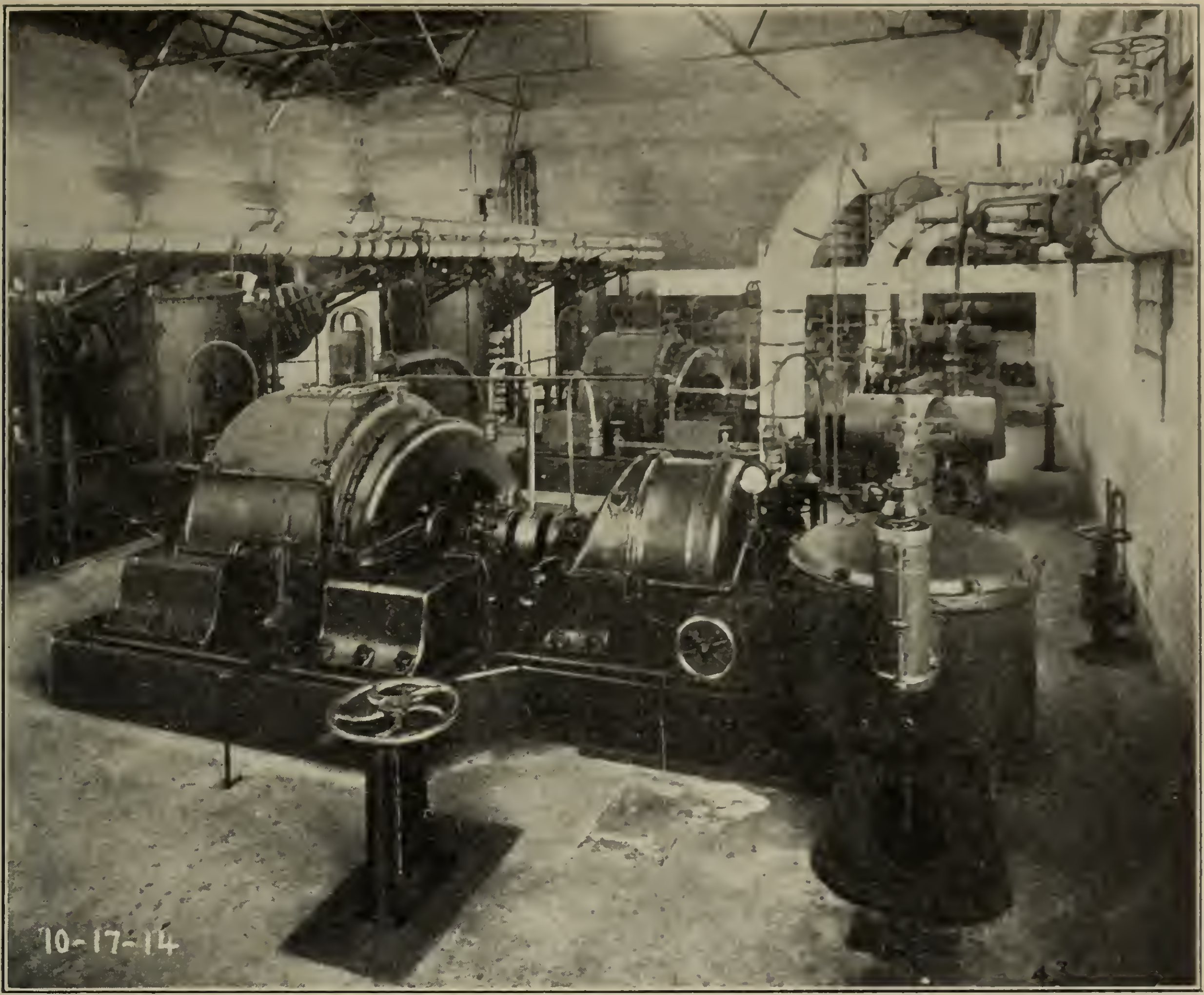


Low-Pressure Oil Burners—Steptoe Type

LOW PRESSURE OIL BURNERS

The cut shows the essential features of low pressure oil burners used on the reverberatory furnaces of the Steptoe Valley Smelting & Mining Company, McGill, Nev., as described by R. E. H. Pomeroy in the Bulletin of the American Institute of Mining Engineers. The air for these burners is supplied at a pressure of only 40 oz. by a motor driven Connersville blower of 42-cu. ft. capacity per revolution. The oil is crude petroleum having a specific gravity of 16.5° Bé., flashing in open test at 199° F. The oil is heated to about 200° F. in a steam heater before going to the furnace, about nine boiler horsepower per furnace-day being required to heat the oil from the line temperature to the burning temperature. The oil is fed by gravity (34 lb., static pressure) through seven burners.

The No. 2 reverberatory furnace, on which a series of tests were made, has the following dimensions at the skimming line: Length, 132 ft. ½ in.; average width, 18 ft. 10 in. The air supplied to the burners for atomizing and burning the oil amounts to about 10% of the theoretical air necessary for complete combustion, the remainder of the necessary air enters the furnace through the burner openings in the firing wall. No checker holes are provided and the charge holes in the roof are equipped with slide gates and "dog houses" to minimize air leakages. The combustion of the fuel is practically complete, the carbon monoxide in the effluent gases being less than 0.5%. The draft at the firing end of the furnace is 0.18 in. of water; in the uptake above the verb the draft is about 1 in., and in the stack 1.4 in. The top of the stack is about 320 ft. above the skimming line of the furnace.



TURBO GAS BOOSTERS

The half-tone above shows a power house interior of the Maryland Steel Company, Sparrow's Point, Md., in which are seen three Rateau Smoot centrifugal gas exhausters installed by the Southwark Foundry & Machine Co., Philadelphia.

Each machine as here shown is direct coupled to a Rateau steam turbine, and has a normal capacity of 900,000 cu. ft. per hour when receiving by-product coke oven gas at 122° F., sp. gr, .40 to .50 (at 60° F., referred to air = 1), the gas being delivered to the machine at a pressure of 10" water column below atmosphere and discharged, at a pressure of 3.75 lbs. per sq. in. above atmospheric.

The steam turbines are designed for a steam pressure of 90 lbs. to the sq. in. and vacuum 26 ins. The maximum capacity may be obtained when running non-condensing. Normal speed, 3900 r. p. m. The Exhausters are of three-stage type. Each impeller consists of a set of forged steel radial blades dovetailed into the shaft, forming a rotating element of unusual strength and stiffness. The operating speeds are well below the critical speed. The passages and guide vanes are shaped to allow the gas to enter and leave the impellers without shock and insure high efficiency. With this construction, also, end thrust is eliminated.

The unit is equipped with a constant suction relay governor with 36" bell, which regulates the speed of the turbine to maintain a constant pressure in the gas collecting main within 2 mm. water column. A centrifugal fly-ball governor is provided on the turbine shaft, which acts as a speed limiting device and controls the admission valve directly. Two exhausters are in use constantly, one for rich gas and one for lean gas from the koppers by-product coke ovens. The piping is so arranged that the No. 1 machine handles rich gas, the No. 3 machine handles lean gas, and the No. 2 machine may be used for connection to either gas main.

LEAD WOOL AND PNEUMATIC CAULKING

The following is an abstract of a paper by C. E. Reinicker, of the People's Gas Light & Coke Company, Chicago, before the Illinois convention. The paper was entitled "The Use of Lead Wool as a Jointing Material, with Especial Reference to a 36-inch Main," and it told of the experiments which led to the adoption of lead wool and pneumatic caulking.

In the first use of lead wool by this company hand caulking was employed, the comparatively small number of joints on each individual installation rendering less conspicuous the excessive cost which would be encountered on a long line of street main.

The company had experimented with pneumatic caulking in 1908, but because of the crudeness of the apparatus, unfamiliarity with the process, some prejudice on the part of the operators and also that the joints on which it was tried were filled with cast lead, the method proved unsatisfactory and was abandoned. The paper then describes at considerable length various experiences and the results of tests and investigations having in view the installation of a new 36 in. main more than 13 miles long. An experimental line equipped with lead wool joints was found to be the only one in which a majority of the joints were "bottle tight."

With the question of the material decided upon, the next step to be considered was the calking. Because of the cost of hand calking this method was not to be thought of in connection with this long line, and it was finally agreed that pneumatic calking was the only available method promising economy.

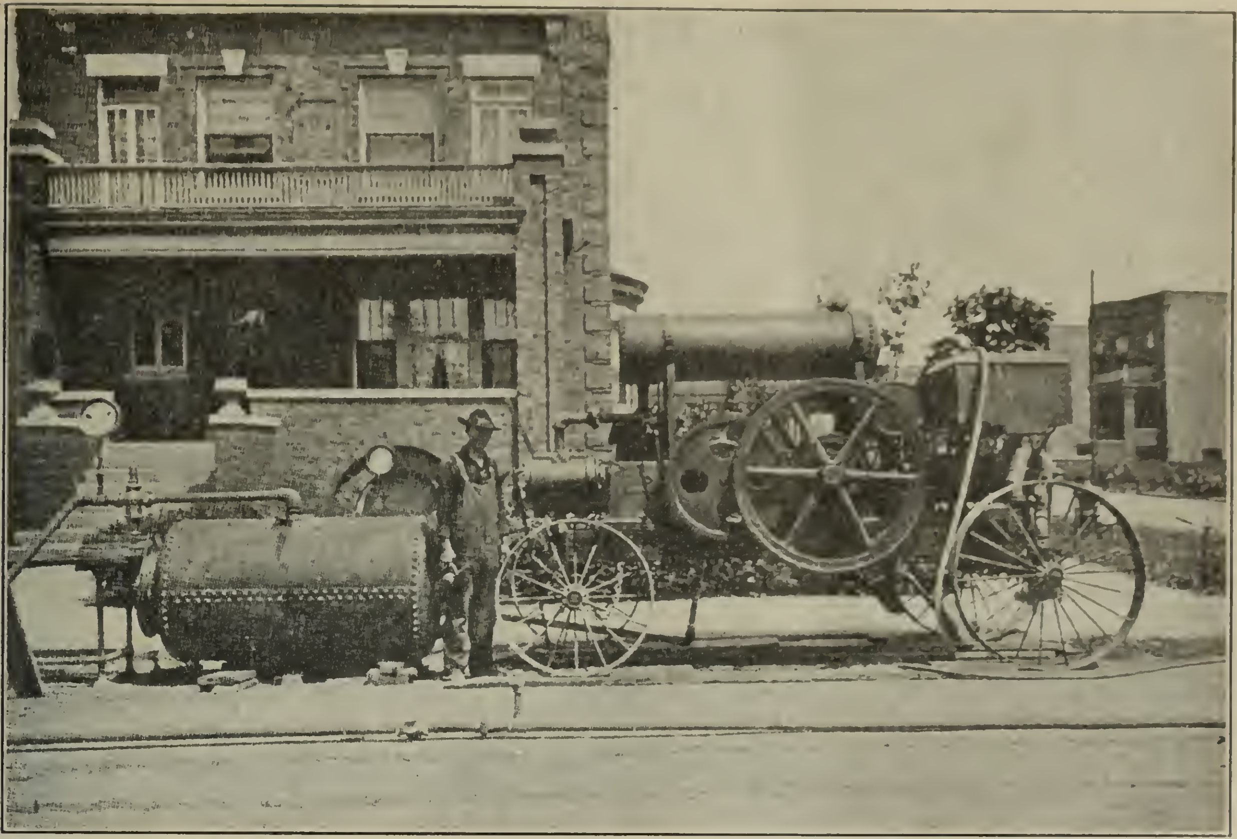
A complete and systematic organization of the supervising and working force was completed before the work was begun. An engineer was placed in charge of the engineering details of the whole route, whose duty it was to see that proper grades were maintained, and that obstacles in the line were removed.

Four gangs were organized for the actual work, the details being as follows: Foreman in charge of the gang; apprentice engineer; foreman of calkers, or inspector of joints; machinist in charge of compressor; time keeper; tool keeper; various straw bosses as necessary. Each gang averaged 130 men and had about ten calkers. For instructing those men who will be directly in charge of the work, a "course of Instruction for Street Men" was started to give the men experience approximating actual conditions; a 36 in. joint was used, made of a short bell and a short spigot of pipe. The bell piece was cut into two parts, the cuts being diametrally opposite and the two halves then held together by bands running around the pipe and fastened by heavy bolts. When a joint was calked the bell piece was then separated, thus exposing the yarn and lead and immediately disclosing the character of the work. Each pair of calkers was required to calk two or three joints in one visit to the shop, and returned for further practice in two or three weeks. From March 11 until April 12 fifty-three men received instruction and training in this method of calking, during which time seventy-six joints were calked and four or five tons of lead wool were used. A close record was maintained of the performance of each man, both regarding the time of operation and the materials used, and by this method a fair comparison of the relative merits of the operators was made possible. To determine the correct amount of calking material which should be used, other 36 inch joints were made up with both lead wool and cast lead, driven up with pneumatic tools and also by hand.

The samples pneumatically calked were uniformly more dense and their specific gravities nearer to the true specific gravities than the hand calked samples. Also, the gravity of the ring of lead wool back of the recess in the bell was more dense and its specific gravity nearer to the true specific gravity than like samples from the cast lead joint. Therefore this test showed that the best and most uniform results were obtained from lead wool calked with pneumatic hammers.

Tests on the relative specific gravities of the calked product under a differing pressure at the compressor show that a specific gravity more nearly approaching the true specific gravity is obtained when the pressure at the compressor is 80 lb.; or, in other words, that a more dense joint is possible with this pressure than with 100 lb.

After these tests it was decided that the 5 inch joint on the 36 inch pipe should be made as follows: Three inches of yarn was to be first inserted and calked by the pneumatic hammers, the weight varying as the size of the joint varied, averaging about 6 or 7 pounds. The remainder of the joint, 2 inches, was to be



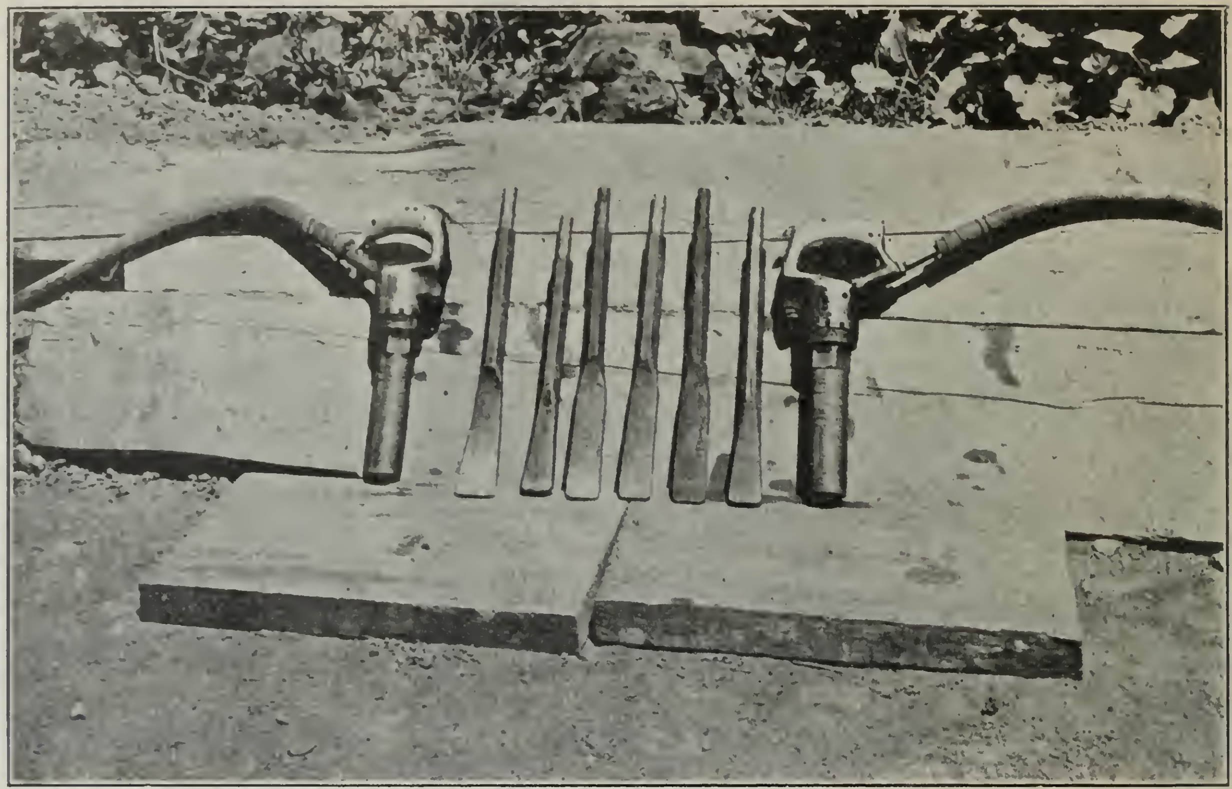
PORTABLE GASOLINE DRIVEN COMPRESSOR.

filled with lead wool, weighing about 75 lb.; this weight also depending upon the size of the joint.

EQUIPMENT.

The portable compressor outfit consisted of a 15 h. p. Otto gasoline engine, 225 r. p. m., directly geared to an N. E.-1 Ingersoll-Rand compressor, 170 r. p. m., with a cylinder size of 8 inches by 8 inches and delivering 76 cubic feet of free air per minute at a pressure of 80 to 100 pounds. Mounted on the frame with the engine and compressor was an auxiliary compression tank 18 inches by 6 feet, and all other accessories, the whole having a shipping weight of 7,200 pounds. Plate No. 1 presents a comprehensive view of this outfit. In connection with each outfit a storage tank 3 feet by 6 feet was provided, so that from 6 to 8 pneumatic hammers could be used at the same time by each gang, since without this tank only 5 hammers could be used simultaneously. The calkers worked in pairs, each man being equipped with a 15-53 H. Ingersoll-Rand Crown valve pneumatic hammer, having a 1⅛-inch bore and a 3-inch stroke, and delivering approximately 1800 blows per minute, Fig. 2 showing the hammers. In addition to the eight hammers used on each gang there were seven additional ones supplied, so that a defective hammer could be replaced without loss of time. In addition to his pneumatic hammer each calker was given a set of eight calking tools and each pair of calkers was provided with a pail containing a hammer wrench, a 10 in. Stillson wrench, an oil can, three cold chisels, one hand calking hammer. The air was carried in a 2 in. steel pipe laid along the side of the trench about 600 feet each way unions every two lengths. At every 20 feet from the compressor and joined by Dart a branch was taken off this line, the branch divided to supply two air hose. Each of these two branches had a valve and attached to it 25 feet of ½ inch hose directly connected to the hammers, this connection being shown in Fig. 3. By this arrangement it was possible to calk a large number of joints without moving the compressor and with no appreciable loss of pressure.

The bell and spigot of the pipe were cleaned before laying, and extreme care was used to carry the pipe home. The centering and blocking were carefully done, so that an even joint would be assured at all quarters of the pipe. After this was accomplished a piece of yarn



HAMMERS AND CALKING TOOLS.

specially prepared for the purpose was tucked into the joint to exclude the dirt, this yarn remaining in place until the calkers were ready to begin work on the joints. The yarn used in calking the joint was prepared at the "camp" and fastened in bundles of various weights, this weight ranging about 7 lb.

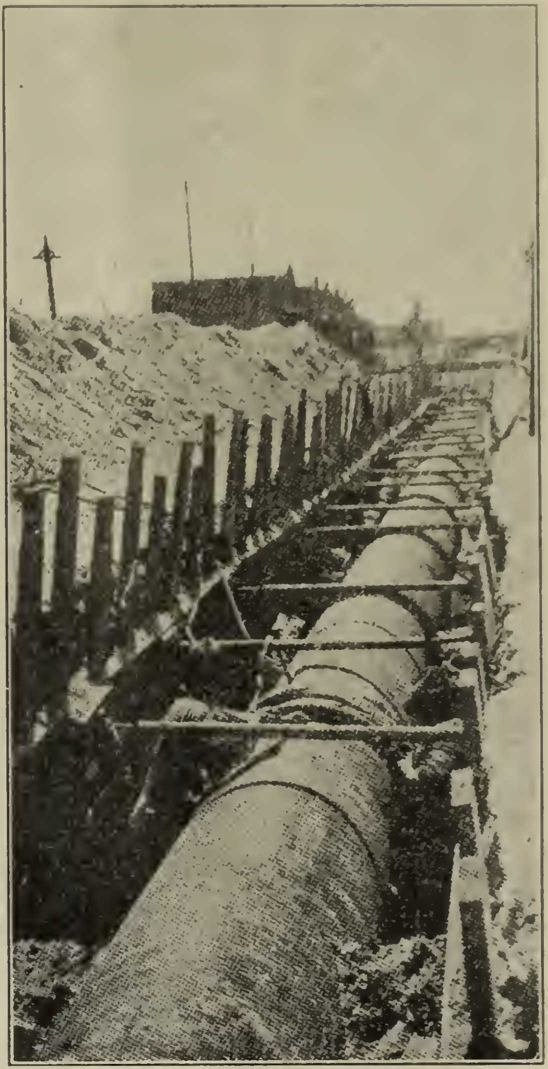
The lead wool was shipped to the gang in sacks of 100 lb. each and it was then rolled into suitable lengths for inserting into the joint, and definite amounts weighed out. This amount varied as the diametral thickness of the joints varied, and it was the endeavor to provide as little as possible over the actual amount needed, to reduce the waste to a minimum, therefore if the joints were averaging 70 lb., 75 lb. was provided; if they were averaging 75 lb., 80 lb. was provided, and so on.

The first step in the joint work was the removal of the yarn which was tucked into the joint at the time it was laid. After this was done, and as a means of additional precaution against dirt, the air hose was used to blow out any that might have been admitted before the joint was protected by the yarn. The first permanent yarn, consisting of about 6 strands was then pushed into the joint. After this was in place and any excess length cut off, it was calked with pneumatic hammers. After this first was tightly driven another layer of yarn was inserted consisting of 8 or 9 strands, the same procedure being followed as in the first case. This method was carried on until the yarn came to within the required 2 inches of the face of the bell, at which point the lead wool was to be started.

Before using the lead wool a shallow galvanized iron pan was placed under the joint to catch any waste that might drop during the calking. Two strands of lead wool were introduced all around the joint, the calkers working from the bottom upward and continuing to the top. When these strands were driven up and even, a third strand was inserted, and so placed as to break joints with the first rings calked. After the joint was finished, the lead wool and yarn that remained, together with the waste lead in the tray under the joint, was gathered up and returned to the "camp," where it was weighed.

After a sufficient length of main was completed to warrant testing, a test was made, taking the air from the compressor. After 15 lb. was reached, each joint was carefully gone over with soap and water. Since the number of the joint was recorded in the name of the men who did the work, it was easily seen which men were negligent. As a matter of fact, except for the first joints calked, few were found lacking under test.

Since the number of joints possible to calk in a day depended on the number of feet of pipe laid, and since this latter depended on the character of the subsoil encountered, a statement of the number of joints calked daily would be of no value. It was necessary, however, that each gang should calk on an average 10 joints per day in order to finish the work on schedule time. There were times, under favorable conditions, when a pair of calkers finished 5 or 6 joints in a 9 hour day; and there were also times when it was possible to lay only 3 or 4 lengths, so only one joint was calked by each pair. As a general average the time of yarning was 43 minutes and that of calking 1 hour and 14 minutes. It was found advisable not to use any lead wool that had become wet, therefore a canvas cover was provided for each bell hole for protecting the men and the lead during a slight fall of rain, and also to provide a shelter for the calkers from the sun during the heat of the day. Rainy days were used to test the line laid, if this were possible, and on this phase of the work some interesting figures were obtained. It required two compressors 2 hours and 45 minutes to fill 2,568 feet of main and one compressor 4 hours and 30 minutes to fill 2,028 feet of main with air at a pressure of 15 pounds.



MEN AT WORK.

REPORTS AND FIGURES ON WORK.

To keep accurate records, daily reports on each gang were filled out by the apprentice engineer. The total number of joints calked was 5,917. The average cost per joint was $7.46, divided into $1.04 for labor and $6.42 for material. The average weight of the material used in each joint was 6.2 pounds of yarn and 72.4 pounds of lead wool. The total number of feet of pipe laid was 69,553, at an average cost of $7.09 per foot. The cost figures are actual shop costs determined from the daily reports and do not contain any overhead expenses.

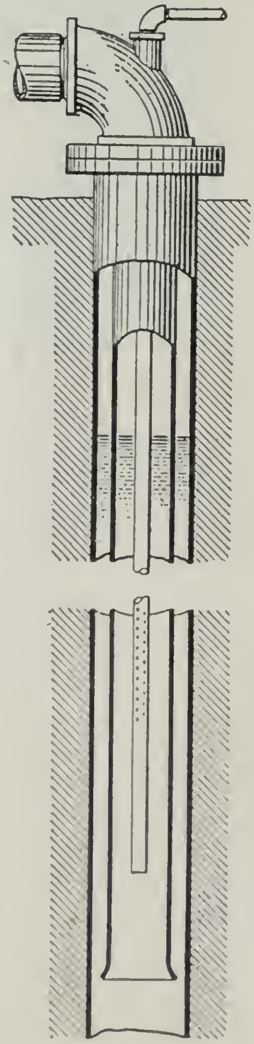
After this main was finished and gas at 5 pounds pressure put into it, everyone connected with the work waited with an air of expectancy for complaints of leaking joints, and it was with incredulity and amazement that it was seen the main held tight, but one break developing. Several stretches of this line have been exposed through other main operations, in all about 150 joints being uncovered at different points, and they are without a fault.

Practically the entire 36-inch main was laid with lead wool furnished by the New York Lead Wool Co., only enough of the product of the United Lead Co. being used for experiment. The product of each of these companies was entirely satisfactory, there being little choice between them. Specific gravity tests showed that each was composed of lead of a high grade of purity, and when calked closely approached the true specific gravity of the fused metal. The change from the use of lead wool furnished by the New York Lead Wool Co., to that of the United Lead Co. was entirely due to the fact that the product of the latter company was supplied in continuous strands, coiled on reels. This aided in eliminating waste and provided an easier means for transportation and handling.

A minor change has been made in the compressor outfit, in connecting the auxiliary storage tank to the compressor by means of a metallic hose, thus eliminating vibration. Air is maintained at 100 lb. in the tank, the outlet having a reducing valve which cuts the pressure to 75 lbs. By this means it has been found that a more uniform supply could be maintained when all the hammers were operating, and also obtaining better joints with the lower pressure.

The efficiency which may be obtained through the use of lead wool and pneumatic calking on large lines of bell and spigot pipe which are to convey gas at even moderate pressures should strongly commend it to gas engineers.

AN AIR LIFT PIPE THAT WILL NOT CLOG



It is not uncommon in using an air lift, to deliver the air through radial perforations in the air pipe near its bottom. Trouble is sometimes experienced in such cases by the clogging of the perforations with precipitate or scale. E. M. Ivens, writing in *Power,* describes a method of avoiding this difficulty. A section of pipe is added to the line below the perforations, as illustrated, and the lower end left unplugged. Thus any scale or dirt is allowed to escape downward while the air follows the path of least resistance through the perforations. Should the perforations eventually become clogged, the air will still have a path open at the lower end. Its use of this path will allow the lift to operate, but will be detected on the gage. The operator can then clean the pipe when most convenient.

A NOVEL AIR COMPRESSOR STUNT

The operating plant of the Canadian Mining & Finance Company, Timmins, Ontario, comprising, mine hoist, air compressor, underground pumps and concentrating mill, is all to be operated electrically, current being supplied from an outside source. To guard against possible delays and to ensure constant operation an additional steam power plant was considered for emergent use. This would have required not only steam boilers but also steam engines of adequate power and electric generators, but in this case only the boilers will be required on account of the two-fold function to be assumed by the compressor and its motor.

The compressor is a two-stage cross-compound Nordberg machine of not unusual type, having cylinders 37 and 22 in. diameter by 31 in. stroke with mechanically operated Corliss valves, both for inlet and discharge. It is to be driven by a 25 cycle synchronous motor at 105 r. p. m. By a slight readjustment of the valves, some changes of connections and a reversal of rotation the compressor is converted into a steam engine and the motor becomes a generator supplying current for driving everything as before except that of course, so far as the story goes, there is no longer any supply of compressed air, and for a mining operation the air would seem to be quite a necessity.

MANY USES FOR LIQUID AIR

That the liquefaction of air is no longer a mere laboratory achievement is far from being generally realized. Many, even accomplished engineers, are astonished when informed that it is now an important industrial process.

ENORMOUS PRODUCTION.

Yet it is certain that, from the plants already in existence on the Linde and Claude systems, there must be produced well over 30,000 gallons of liquid air hourly. Of this output, by far the greater part is utilized in the production of pure oxygen. But a rapidly increasing number of installations are being put down for the manufacture of nitrogen, while the neon which is readily extracted as a by-product, is finding a useful application in industrial lighting. Experiments, giving good results, have also been made with liquid oxygen explosives; and a number of liquid-air plants have been put down for the production of hydrogen.

The separation of the oxygen and nitrogen is effected by liquefying the air and re-evaporating it slowly. The difference in the boiling points of the oxygen and nitrogen causes most of the nitrogen to come off as a gas, and most of the oxygen to remain behind as liquid. A special form of rectifying tower enables the separation to be completed. In the manufacture of oxygen, the liquid-air process has superseded almost all others, chiefly owing to the low cost of production which it permits.

OXY-ACETYLENE BLOW-PIPE.

The increase in the consumption of oxygen is almost entirely due to the successful application of the oxy-acetylene blow-pipe for welding and cutting metals. In 1911 the consumption of oxygen in Germany was 150,000,000 cubic feet, in France 100,000,000 cubic feet, and in England about two-thirds of that amount, and it is estimated that at least 90 per cent. of these totals was used for oxy-acetylene work, about one-half of this amount for welding and one-half for cutting. There are, it is stated, some fifty liquid-air oxygen plants at work on the Continent of Europe, and the British Oxygen Company in this country has all of its eight factories equipped in this fashion. But in the United States only five liquid-air oxygen plants had until recently been put down, although there are in operation at least two electrolytic installations.

NITROGEN FOR FERTILIZERS.

The market for nitrogen among makers of artificial manures is a large and growing one, and in supplying it liquid-air plants seem destined to be brought more and more into use. At present the world's consumption of nitrogenous fertilizers is upwards of 4,000,000 tons annually, and it appears certain that this figure, as virgin soils become exhausted, and the natural sources of supply in Chile diminish, will be greatly exceeded. Even as it is, liquid-air plants are in existence whose combined capacity will produce enough nitrogen to make 250,000 tons of calcium cyanamide yearly.

Formerly the nitrogen for this process was all supplied from the Birkeland and Eyde plants, which extract it from the air by electrical deposit. The efficiency and cost of working of the Birkeland and Eyde process, however, compare very unfavorably with those of liquid air. The cyanamide, as is well known, is made on the Frank-Caro principle, by passing pure gaseous nitrogen through retorts containing calcium carbide, heated to about 800 degrees Centigrade. For this purpose a purity of 0.997 is demanded, and a purity of 0.998 and over has, on the Claude and Linde processes, been obtained. On the Claude system nitrogen selling at 1 franc can be produced for 50 to 60 centimes per kilogramme.

Liquid air is also used indirectly in connection with at least two other nitrogen processes, in which it is necessary, or at least advantageous, to use an excess of oxygen. The more important of these is the Birkeland and Eyde method of extracting the nitrogen from the atmosphere by electrical deposit. In this process it has been found that if, instead of air, a mixture of nitrogen and oxygen in equal volumes is used, a yield may be expected of at least 625 kilogrammes of nitric acid per kilowatt-year, instead of only 500 as at present.

The other process, due to Haeusser, depends on the fact that after combustion at a high temperature—by an explosion of gas, for example—a part of the nitrogen in the air burns, and remains oxidized, if the explosion is instantaneously followed by rapid cooling. In this process also it has been found that an excess of oxygen in the air has large effects on the yield to be expected.

Finally, nitrogen made by the liquid-air apparatus has found a use in the manufacture of aluminum nitride from bauxite (Al_2O_3). The nitrogen is passed over a mixture of three volumes of charcoal to one of bauxite, heated to whiteness, and the nitride and carbon monoxide are produced. For supplying the nitrogen for this process a Claude plant, with a capacity of 300 cubic meters per hour, has recently been put down in France.

In the manufacture of hydrogen the liquid air does not, of course, form the raw material, but is used externally. The raw material is water-gas, the composition of which is 48 to 54 per cent. hydrogen, 42 to 44 per cent. carbon monoxide, 2 to 5 per cent. carbon dioxide, 3 to 5 per cent. nitrogen. Carbon dioxide is easily removed by absorption in lime, and since, of the remaining constituents, hydrogen has by far the lowest boiling point (— 253 degrees Centigrade), it can easily be separated by liquefying the other gases with liquid air, and allowing the hydrogen to escape as a gas into a suitable holder. The liquefied mixture, which is mainly carbon monoxide, is conveyed to an internal-combustion engine, and thus serves to develop the mechanical power necessary to drive the installation. Suitable interchangers are provided, as in the liquid-air plants for economizing the cooling effect. The process is due to Messrs. Linde, Frank and Caro.

USES OF HYDROGEN.

The outlet for the hydrogen is chiefly for the conversion of oils into the fats required in soap and margarine making, etc. It is also employed for inflating balloons, and, in the manufacture of metallic-filament lamps, for the envelopment of the filament during its preparation and reduction; and recently a Linde plant, with a capacity of 2,000 cubic meters per hour, has been put down by the Badische Anilin for use in the manufacture of synthetic ammonia.

An advantage of the liquid air over the electrolytic process is that excess hydrogen passed through the oils, and thereby rendered impure, and hydrogen that has become diluted with air in balloon work, can be returned to the apparatus and readily purified by condensation of the foreign matters. In addition to hydrogen, nitrogen has been used extensively for the envelopment of the metallic filaments during their manufacture, but it is expected that both of these gases will be replaced by argon, which can readily be produced from the liquid-air apparatus as a by-product. Argon may even be utilized in lighting tubes, similar to the neon tubes about to be described.

NEON.

Nitrogen and oxygen are naturally the two principal products of the liquid-air process, but neon—once regarded as a rare gas—is produced as a residuum from the Claude apparatus in no inconsiderable quantities. In fact, from a plant with a capacity of 50 cubic meters of oxygen per hour, about 100 liters are produced per day, the proportion present in the atmosphere being 1 in 66,000. It is well known that neon offers an exceptionally small resistance to the passage of the electric discharge. This property inspired M. Claude with the idea of using the gas obtained from his apparatus in lamps, similar to the Moore nitrogen tubes, and after some difficulties he has met with a fair measure of success. Neon lamps made by him were used to illuminate the colonnade of the Grand Palais des Champs Elysées on the occasion of the Automobile Exhibition in 1910, and fifty of his neon tubes, each 6 meters long, decorated the church of St. Ouen at Rouen during the fêtes of the Norman Millenary.

EXPLOSIVES.

The use of liquid oxygen in explosives promises to be considerably developed in the future. In the early experiments of Linde, the liquid containing 50 per cent. of oxygen, which was obtained from his original apparatus, was poured on to fragments of wood charcoal from 2 to 4 millimeters in size. The fragments were kept from scattering, as the liquid boiled, by making them into a sponge with one-third their weight of cotton-wool. In more recent experiments, at the cutting of the Simplon Tunnel, a mixture in equal proportions of carbon and petroleum, which took up eight parts of liquid oxygen, was used with some success, and lately excellent results have been obtained by Messrs. Claude and D'Arsonval working in collaboration for the French Government. The chief object of their investigations was to produce an explosive which gave rise to no injurious gases. For this purpose a mixture of powdered aluminum, with an excess of liquid oxygen, was tried, with a very encouraging success, and the explosive was found to be equal to twice its weight of gunpowder. Further experiments by the same investigators with carbon-oxygen explosives show that these have the same power as dynamite, and, as the cost of each of the constituents is less than two cents per pound, it is predicted that the new explosive will, as soon as further experiments are completed, be widely used. The principal difficulty in the way of its adoption is the transportation of the liquid oxygen, but this should shortly be overcome.—*Engineering*, London.

Official announcement has been made by the Bureau of Mines that the cost of production of the 300 milligrams of radium bromide it has so far made was at the rate of $60,000 per gram ($1,700,000 per oz. Avoirdupois) and this is said to be a marked reduction from the prices formerly prevailing in the open market.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

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THE PANAMA PACIFIC EXPOSITION

It might easily be charged against Compressed Air Magazine that it has not done its duty in the way of promoting the publicity of the great international exposition now getting into full swing. In fact the gigantic enterprise has been so long, so voluminously and so efficiently advertised that our help was not needed, even if it could have been of any account. No world's exposition has ever made larger promises and none has more magnificently fulfilled them.

The exhibition occupies two and a half miles of the water front of the Golden Gate with a range of green hills for a back ground when viewed from the waters of the bay, and here are picturesquely grouped a collection of great buildings upon which have been lavished the skill of great architects and the decorative resources of the artists in color and form. On one side or end of the show proper are the buildings erected by the different States of the Union and foreign countries represented at the fair, with race track and fields for aviation and outdoor sports, and at the other is a region called The Zone, given over to popular amusement patrons.

All this is merely the outside. There are 80,000 exhibitors represented on the grounds, and, rather curiously, it is stated that the total weight in exhibits handled by the traffic department is 80,000 tons. There is practically no limit to the range and variety of the exhibits. All interests and tastes will be catered to and none can go empty away. The things which would have been shown but have been held back by the war will scarcely be missed in the mass actually presented.

There is every promise of a record breaking attendance. The foreign visitors may be few indeed, but those who have been kept away will be outnumbered many times over by these from this side who in a normal year would have visited Europe but now will go to the Pacific Coast instead. Not least among the things accomplished by the exposition will be the impulse given to many Americans to see their own country.

Most notable will be the official meetings of organizations of every type. There will be the Engineering Congress and the individual gatherings of the various technical societies. Nearly four hundred state, national and international associations have signified their intention to hold conventions and reunions at San Francisco during the season, and for these ample accommodations have been provided. Most of these will be held in the special Convention Hall on the grounds, but there will also be many important and interesting gatherings in the State buildings and elsewhere. This opportunity of a lifetime strongly appeals to every American, and in fact to every one in touch with modern civilization.

NEW BOOK

Tunneling, Short and Long Tunnels of Small and Large Section driven through Hard and Soft Materials, by Eugene Lauchli, 248 pages, 6 by 9 in. nearly 200 illustrations, McGraw-Hill Book Company, New York. Price $3.00.

This is an excellent work prepared by an engineer of wide experience both in the United States and in Europe, who has the faculty of orderly, concise and comprehensive presentation without the introduction of any extraneous matter. The work is composed to a large extent of results of personal observations and studies, together with data collected from direct and reliable sources. It adheres strictly to the one topic and presents genuine information and reliable records of tunneling actually accomplished. It also fully discusses means and methods and deduces practical reasons for their selection and adoption under different conditions. W. L. S.

THE ADVERTISING PAGE AND ITS VALUE TO THE READER

BY CHAS. A. HIRSCHBERG.

It has been aptly said that "Salesmanship is the Sale of Goods for Profit." It should be for the profit of both the buyer and the seller; the buyer first of all. Before the maker can hope to profit, the goods must profit the user.

Advertising from the reader's angle, is the means by which he is put in touch with an article for which he has need. From the manufacturer's viewpoint, it is the means by which he makes known to the reader that he has something to sell that will profit him in his work, whether it be a new device or a better way to utilize an old one.

Advertising has a big mission to perform. It disseminates information and increases knowledge. It informs, interests, educates and inspires. It tells the reader of new developments in the field of manufacture. Something new is being discovered every day. For instance, the Jackhamer drill is a far different and better machine than the reciprocating drill of yesterday. It has effected a decided increase in the speed of drilling rock for blasting. In many cases it has almost doubled the progress formerly possible, and at the same time has lowered the items of labor and power cost.

It was the advertising page that first put you "wise" to this wonderful little tool, and the same is true of a large percentage of your mine equipment.

Advertising interests because of the part it plays in informing the readers of the progress John Jones is making on work akin to his own. In that way it educates him in better means and ways of doing things, and it inspires the emulation of the successful neighbor.

It is incumbent upon the subscriber to read the advertising page and to study it carefully, for tomorrow may bring forth a better Jackhamer drill; something with which to supplant the thing of today, making that job more quickly accomplished, safer and at a lower cost.

Advertising tells how to economize; how to increase production and how to conserve resources. It goes further. It is the acid test of quality, for a poor article cannot survive the test of continuous publicity any more than it can stand close personal inspection, therefore advertising, extensive and persistent, is in the nature of a guarantee of quality. It shifts the responsibility of selection from the purchaser's shoulders onto the advertiser. It is an insurance against misrepresentation and against trouble.

When you buy advertised goods you don't buy blindly, for you are enabled to choose your purchase from the entire manufacturing field. In other words, it is like dealing with a big department store, with its extensive lines of goods from which to choose.

Advertising has brought the four corners of the world into intimate relation with each other. The man in Alaska is told how the man in Arizona does things and the kind of equipment he uses to obtain his results. The man in California profits through the knowledge the advertising page conveys of a new and better drill, compressor or drill sharpener, built perhaps in Pennsylvania, New York, or some other corner of this big country of ours.

You may not need the article immediately, but in reading the advertising page you are fortifying yourself against tomorrow, against the inevitable day when the march of time and progress will demand the adoption of other means and other methods to successfully cope with your problems.

The very fact that you are willing to pay $1, or whatever the subscription price may be, is an indication that you read the text pages with the object of keeping in touch with your field, for unless you do you are not getting the worth of your subscription price. But, on the other hand, are you really getting your money's worth if you neglect the advertising pages?

Good advertising vies with the text pages in point of interest, instructiveness and value; it is confined not merely to a brief description of the goods, but also invariably contains a citation of performance, of upkeep, and the cost of doing things out in the field. This is as it should be, for the manufacturer is usually in closer touch with the work out in the field than the editorial departments of the paper, at least, on such jobs where his equipment is being used.

There is a service which the reader can perform for the publisher and the advertiser that in the long run will accrue to the benefit of the industry. When writing the manufacturer mention the advertisement and the name of the paper. This is but a small thing to ask of the reader. On the other hand to the publisher and the advertiser it is of extreme importance, for it enables the advertiser to spend his money judiciously and helps the deserving paper.

How many are willing to admit, for instance, that the Leyner Sharpener that is saving from 25 to 75% in the cost of sharpening drill steel first came to their attention through the advertising page, that, perhaps unconsciously, it was the advertising page that led to its purchase? And if you are willing to admit it, do you do so?

The survival of a product on the advertising page is the true test of quality, for no manu**facturer could long afford to advertise an infe**rior product—therefore, in buying advertised goods lies your "protection."—*Min. & Eng. World.*

TUNNEL CANALS IN ENGLISH COAL MINES

Tunnel canals are by no means uncommon in England, but the Bridgewater subterranean canal is quite different from the other coal lands; indeed, says the Technical World Magazine, there is nothing quite like it elsewhere in Great Britain, or, for that matter, in any other part of the world.

John Brindley, the engineer in charge when the canal was built in 1759, laid down within his coal mines a system of underground railways, all leading from the face of the coal (where the miners were at work) to the shafts which he had made at different points in the tunnel, through which the coal was shot into the boats waiting below to receive them.

First a large basin was excavated at the entrance to the pits at Worsley, capable of holding a number of specially constructed barges and serving as a head for navigation. From this basin the barges entered the mine by means of an underground canal with two semi-circular arches or mouths, and moved for a mile right up to the different workings. Subsequently, the canal extended for about six miles and then branched out in different directions with the total length of nearly 40 miles. Where the tunnel passed through rock it was simply hewn out. This underground passageway, therefore, acted not only as a drain and water feeder for the canal itself, but also as a means of carrying the facilities of navigation to the very heart of the collieries.

Worsley Basin lies at the base of a sandstone cliff several hundred feet high, covered with luxuriant vegetation. The smaller aperture is the mouth of a canal which runs for about a mile, and serves to prevent the congestion which would inevitably be caused by the entrance and egress of so many barges passing through a single passage. The other archway is the entrance to a wider channel, which extends for several miles to Bolton, and from which other canals diverge in different directions. The barges were long and narrow, each holding about 10 tons of coal, and were drawn along the tunnel by means of staples fixed in the wall. When the barges were empty, and consequently higher out of the water, the bargemen propelled themselves along the "legging," as it is called.

In the tunnels of early date, towing paths were never constructed and, except where steam haulage is in use, the method of propelling boats through such tunnels, down to the present time, is either "shafting" or "legging." "Shafting" consists of pushing with a long pole, or shaft, against the top or sides of a tunnel while walking from forward aft along the boat, and is generally only used in short tunnels.

"Legging" is usually performed by two men one on each side of the boat at the fore end, who lie down on their backs and push against the tunnel sides with their feet. If the tunnel is too wide to admit their reaching the side wall with their feet from the boat's deck, boards projecting over the boat's side, termed wings, are brought into use for them to lie on. When the roof of a tunnel is low, one man can "leg" an empty boat lying down on the top of the cabin.

"Legging" is hard work, and it is difficult to realize that in former days it used to be performed by women as well as by men. At tunnels where the traffic is good, professional "leggers" are in attendance, who take their turn assisting boats through as required. At the old Harecastle Tunnel a "legger" may be engaged for less than half a dollar for the passage through, which generally takes about three hours.

The canals are still in use, but women have dropped out of the profession.

IMPORTANT CHEMICAL DISCOVERIES

The Bureau of Mines is doing remarkably efficient work in various fields and its latest achievement is an epoch maker. Secretary Lane announces simultaneously the discovery of two related chemical processes, one of which will greatly increase the supply of gasoline, while the other may make the United States independent of all the world for its supply of essential materials required in the dye industry and in the manufacture of high explosives. It is promised that by the first process the gasoline output of the independent refiners may be increased from 12,000,000 barrels a year to 36,000,000 barrels, or greater than the total production of the entire world. By the second process the important products toluol and benzol, which have heretofore been obtained from coal tar, are produced from crude petroleum. These are important bases for both dye stuffs and high explosives.

These discoveries are the result of years of research by Dr. Walter F. Rittman, chemical engineer of the Bureau of Mines, the work having been done in the finely equipped laboratories of Columbia University. To prevent monopoly in the use of these discoveries Dr. Rittman has applied for U. S. patents, these to be dedicated to the whole American people.

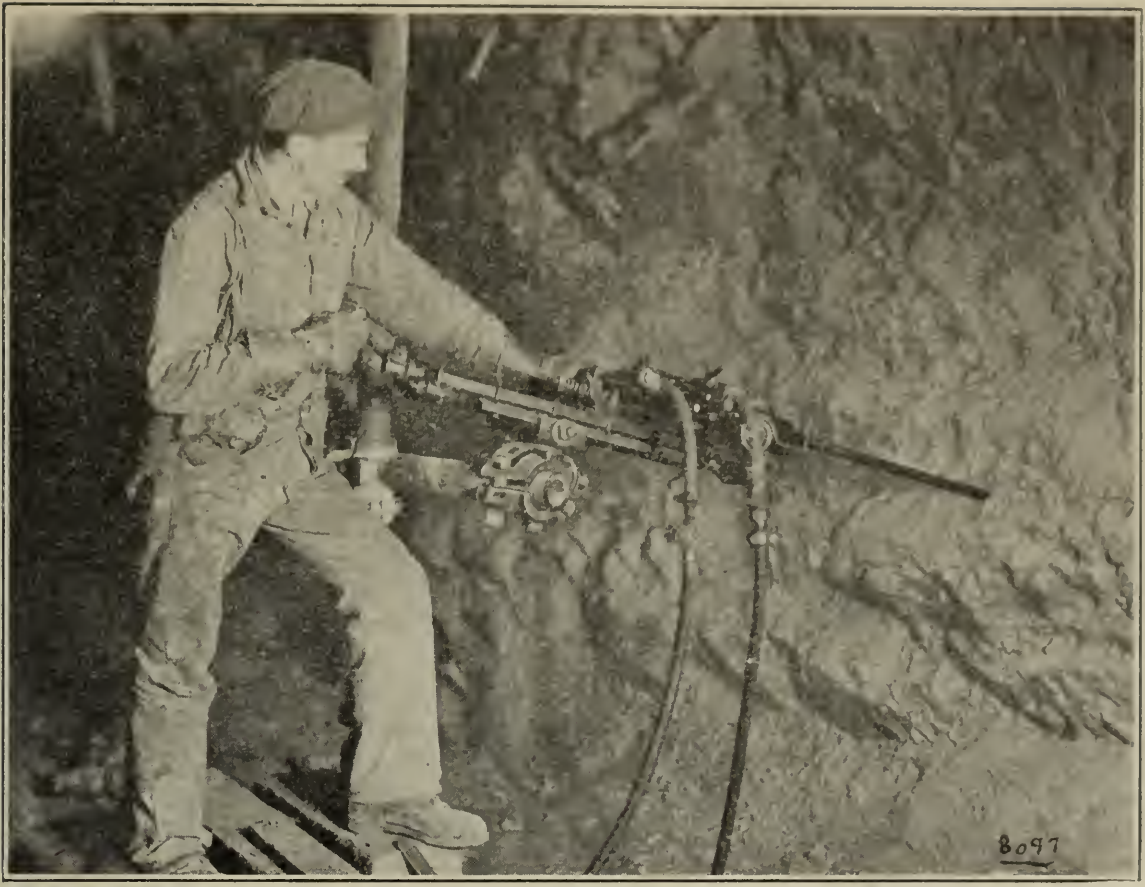
MOUNTED JACKHAMER DRILLS

The Jackhamer drill was originally designed for drilling down-holes of various depths up to, or rather down to, about 12 ft.; but, due to the light weight of the machine, which is around 40 lb., it was found thoroughly feasible to employ it for drilling holes approximately horizontal as well. When such "flat" holes are to be drilled intermittently the regular unmounted Jackhamer is a thoroughly practical tool, but where continuous drilling of flat holes has to be carried on, the effort of holding the drill to the work is apt to tire the workman.

Realizing the demand for a mounting that would not be cumbersome, but that at the same time would be heavy enough to withstand rough usage, there has been developed, after considerable experimenting, the mounting shown in the accompanying illustrations, which is known as the "JM-6" type

The Jackhamer, used in conjunction with the "JM-6" mounting, has been found thoroughly practical for such flat-hole work as drifting and underhand stoping in metal mines, where shallow holes are required, and for breaking down coal and driving gangways in coal mines.

It is but an instant's work to clamp the standard unmounted Jackhamer in the carriage of the "JM-6" mounting. Therefore, a single drill may be used conveniently for the two-fold purpose of drilling flat holes in the heading and for down holes on the bench without loss of time in making changes. Whether used as a mounted or a hand drill the Jackhamer retains all the advantages due to its rapid drilling speed, its self-rotating feature and the efficient means for keeping the drill hole clean. A water feed device of the Leyner type has recently been developed for



MOUNTED JACKHAMER.

use with the Jackhamer whenever trouble from dust arises. The "JM-6" mounting is adapted for use with both plain and water-feed types of Jackhamers. The clamp which grips the handle of the drill is provided with a cushion spring to take up the shock when a steel is being pulled out of a hole. The forward clamp on the carriage does not grip the machine firmly, but serves only as a support and guide.

The "JM-6" mounting is adapted for use either on the arm of a vertical column or a horizontal shaft bar, and the cone upon which the shell rests will fit into any 5-in. Sergeant saddle or clamp. The sliding cone gives a quick adjustment when setting up and can be used to increase the length of feed whenever necessary. The length of the screw feed is fully 24 in. Adding to this the slide of the cone on the shell, which is over 19 in., it will be seen that a total travel of over 43 in. may be obtained whenever desired. The total weight of the mounting is 63 lb. Steel castings and drop forgings are employed throughout in its construction, thus effectually insuring it against hard usage.

NOTES

All rocks contain some water, but some, such as the granites, carry only an inappreciable amount. Sandstone, on the other hand, has an absorptive capacity of a gallon or more of water to the cubic foot of rock and is the best water bearer of the solid rocks.

More inefficient men are talking about efficiency these days than about anything else. It is beginning to seem as though a man who has proved a failure at nearly everything else, becomes an efficiency engineer.—*'Black Diamond.'*

Daylight can be seen at the portal of the Snake Creek tunnel, Park City, Utah, from the face which is in over two miles.

Ignorance can defeat all safety precautions. Two Kentucky Miners went into a cloud of powder smoke and sat down to wait for it to clear away. They died, as did three others in the same state from the same cause. A little information would have clinched "safety first" in those cases.

William Murdock lighted his house with gas from coal in 1792, he fitted up a gas making machine at Soho in 1798, and illuminated Boulton and Watts factory in 1802. Mr. Winsor established the first public gas lamps in Pall Mall about the year 1805.

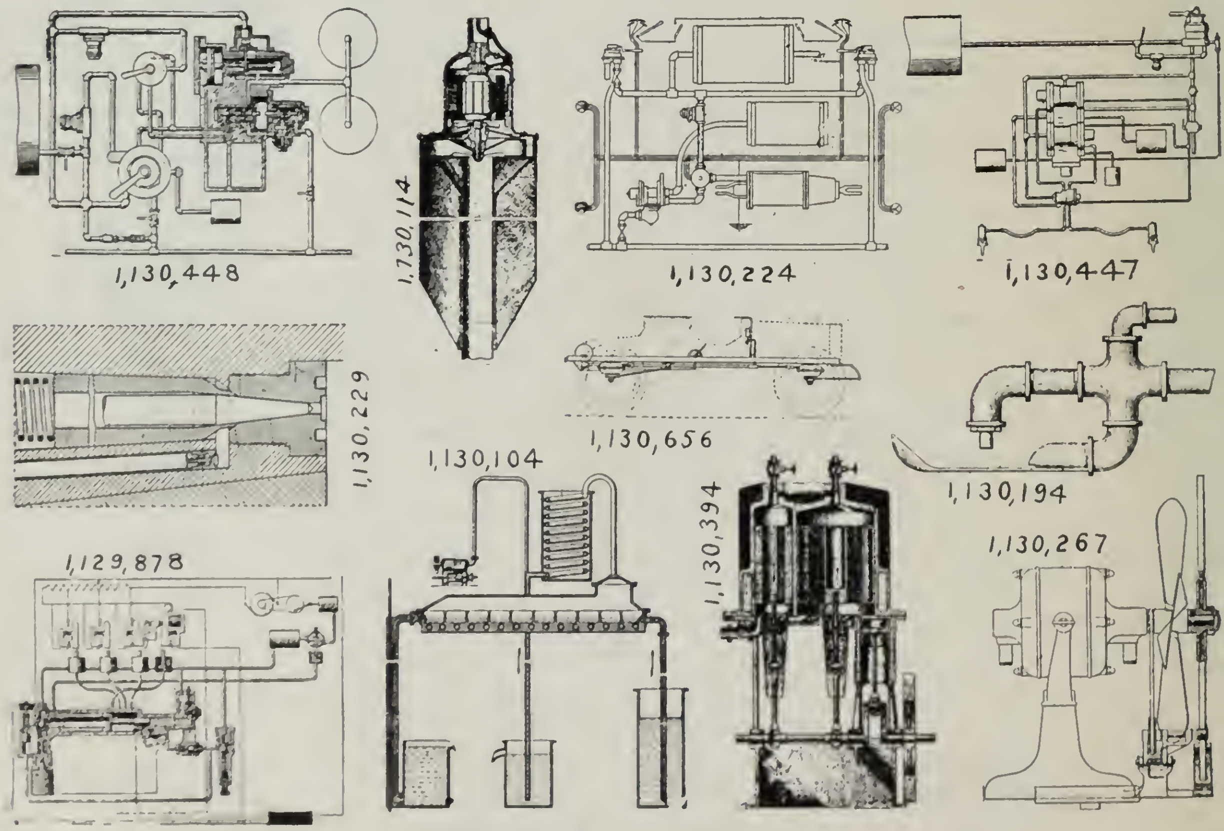
Joplin district, Missouri, has a record of more than fifty years of continuous ore production, aggregating nearly $300,000,000 in value, which during the last ten years has averaged from $12,000,000 to $17,000,000 a year, and will this year exceed $20,000,000.

In a bottle factory in Cincinnati three lines of air piping are required. A vacuum of 26 in. is carried to draw the glass into the mold, air at 20 lb. gage pressure is used to blow the gas to fill the mold, and an air blast at a pressure of 5 to 6 oz. is directed upon each mold to cast it to the proper temperature for handling the glass. In the same plant also air at 200 lb. is used to start the gas engines.

More than 100 entombed miners have been saved from certain death by the life savers of the U. S. Bureau of Mines. The bureau now maintains six rescue stations in mining districts, together with eight rescue cars, which visit the various mining camps and train the men in different kinds of rescue work.

Jozsef Vig of Witherbee, New York, has patented, No. 1,131,300, a combined parachute and life preserver in which devices may be operated to cause the parachute to open automatically. In descending air is forced by the descent of the parachute through suitable passages and joints into the life preserver which latter may encircle the wearer in the usual manner so that the operator will be gradually lowered in the water and when in the water will be buoyed by the life preserver.

It is reported from South Africa that a new petrol substitute has been invented which, it is stated, can be supplied at 3¾d. per gallon, even then leaving a profit of 48 per cent. The inventor is said to be a well-known analytical chemist, who has been engaged for twelve years as chief chemist at one of the largest sugar factories near Durban. It is stated that he has devoted a great deal of attention to the question of obtaining a motor spirit from molasses, and the result of his labors is a petrol



Pneumatic Patents March 2.

substitute to be called Petrolex. A company has been formed to exploit this process, which is said to produce a motor spirit of greater efficiency than petrol.—*The Engineer*, London.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 2.

1,129,878. REGULATING DEVICE FOR MOTOR-DRIVEN COMPRESSORS. Frederick L. Lucker, Brooklyn, and Allan O. Carpenter, Corning, N. Y.

1,130,229. FUEL-SPRAYER. Sven Gustaf Wicelius, Stockholm, Sweden.

1,130,267. HUMIDIFIER AND AIR-CLEANER. George Brewer Griffin, Edgewood Park, Pa.

1,130,394. COMPRESSOR FOR GASES. Horatio G. Gillmor, Washington, D. C.

1,130,447. AUTOMATIC TRAIN-BRAKE-CONTROL APPARATUS. Walter V. Turner, Edgewood, Pa.

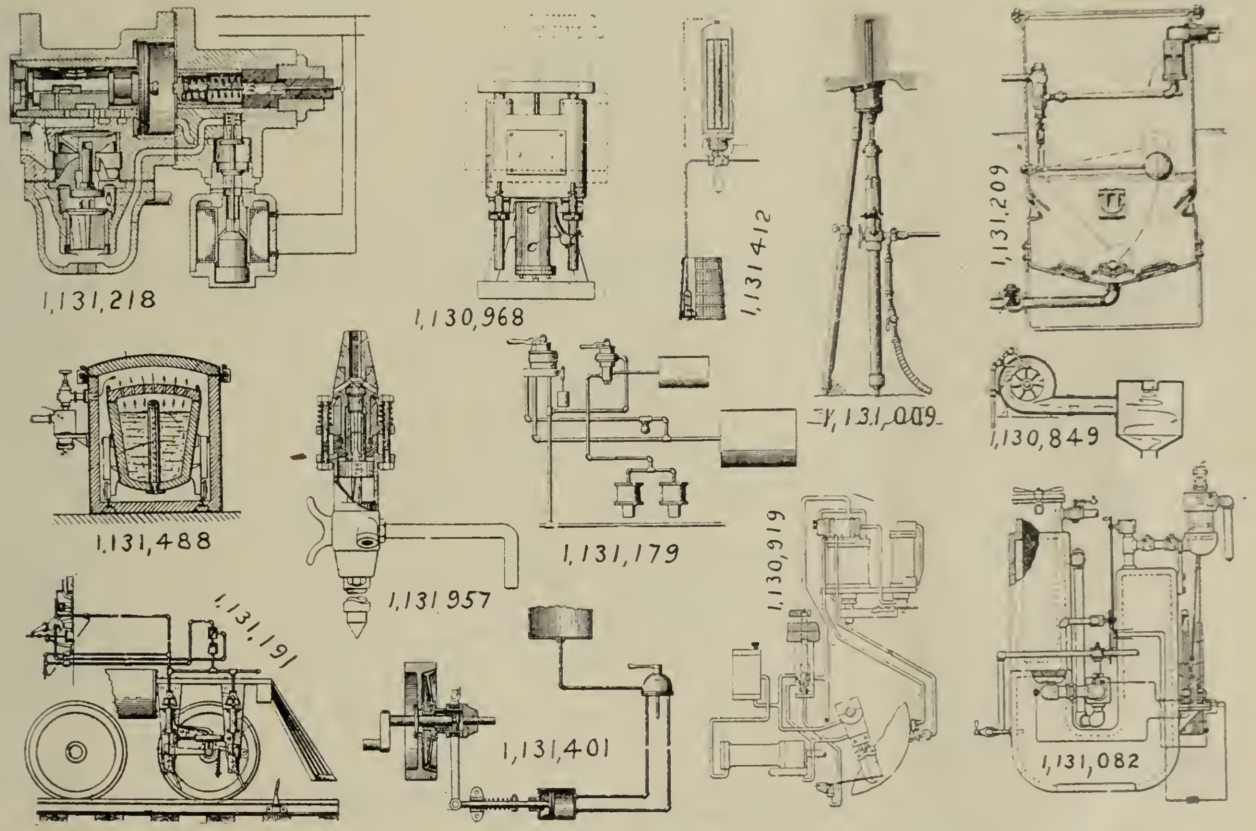
1,130,448-9-10. FLUID-PRESSURE BRAKE FOR LOCOMOTIVES. Walter V. Turner, Edgewood, Pa.

1,130,477. PNEUMATIC RAILWAY-SWITCH. Charles Chappelle, Oklahoma, Okla.

1,130,518. PNEUMATIC-DESPATCH-TUBE APPARATUS. Chester Snow Jennings, Boston, Mass.

1,130,656. PNEUMATIC SPRING FOR VEHICLES. Warren W. Annable, Grand Rapids, Mich.

1,130,679. VACUUM WORK-HOLDER. Gray Staunton, Chicago, Ill.



Pneumatic Patents March 9.

1,129,897. AIR-MOISTENING DEVICE. George B. Owen, Jr., Brooklyn, N. Y.

1,130,101. PNEUMATIC DEVICE FOR MUSICAL INSTRUMENTS. Martin Newcomer, New York, N. Y.

1,130,104. PROCESS FOR THE PRODUCTION OF NITRIC ACID. Fritz Rashig, Ludwigshafen-on-the-Rhine, Germany.

1,130,114. VACUUM CLEANING APPARATUS. Howard Small, Wyncote, Pa.

1,130,194. OIL-BURNER. Alfred Papillon, Lowry, La.

1,130,224. AIR-BRAKE SYSTEM. John Eugene Wallace, New York, N. Y.

1. A system of valves rotated by magnetic torque into various positions for the purpose of controlling the admission and discharge of fluid pressure to and from the brake cylinders on a train of one or more cars, and put in parallel operative relation by the use of three or more train wires in which electric curent shall flow in a given direction.

MARCH 9.

1,130,827. APPARATUS FOR GENERATING OZONE. William John Knox, New York, N. Y.

1,130,849. AIR COOLING AND FILTERING DEVICE. James M. Seymour, Jr., Newark, N. J.

1,130,884. PNEUMATIC JACK FOR MOTOR-CARS. Edward B. Blakey and Rufus B. McCollum, Kansas City, Mo.

1,130,918-9-90. APPARATUS FOR PRESSING GLASS ARTICLES. William J. Miller, Swissvale, Pa.

1,130,940. PROCESS FOR THE SYNTHESIS OF GASES. Leland L. Summers, Chicago, Ill.

1,130,957. FRONT-HEAD CONSTRUCTION FOR SELF-ROTATING HAMMER-DRILLS. Lewis C. Bayles, Easton, Pa.

1,130,968. MOLDING-MACHINE. George L. Grimes, Detroit, Mich.

1,131,009. DUST-COLLECTOR FOR ROCK-DRILLS. Frank Rylander, Dumont, Colo.

1,131,052. DUST-COLLECTOR FOR ROCK-DRILLS. Emmet F. Galligan, Idaho Springs, Colo.

1,131,082. VACUUM-PRODUCING APPARATUS. John Priest, Philadelphia, Pa.

1,131,178-9-80. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,131,191. AUTOMATIC TRAIN-CONTROLLING DEVICE. Louis C. Werner, Webster, Mass.

1,131,209. LIQUID-ELEVATING APPARATUS. Edwin Chamberlin and Andrew M. Gardner, Avella, Pa.

1,131,218-9. ELECTRICALLY-CONTROLLED BRAKE MECHANISM. Edward H. Dewson, New York, N. Y., and Walter V. Turner, Edgewood, Pa.

tion of the first spring, and fluid pressure actuated means for nullifying the effect of the second spring.

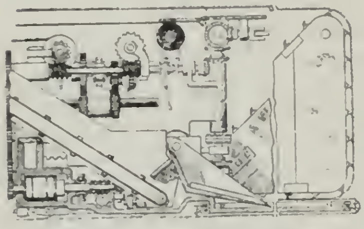
1,131,412. PNEUMATIC DEPTH-INDICATOR. Harry S. Parks, Philadelphia, Pa.

1,131,420. AIR-CONTROLLING VALVE. Harry L. Rider, Oil City, Pa.

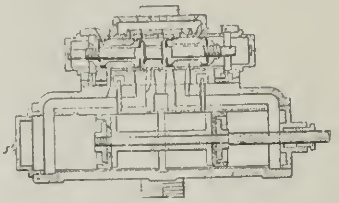
1,131,488. VACUUM PROCESS FOR PRODUCTION OF STEEL. Eugen Dolensky, Frankfort-on-the-Main, Germany.

1. A process for purifying metals consisting in heating a clearing vessel to the temperature approximately of the molten metal to be purified, placing the molten metal therein and subjecting same to the action of a vacuum, substantially as and for the purpose described.

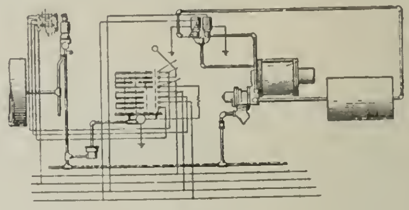
1,131,554. BLOWER. Theodore Jonathan Ritter, New York, N. Y.



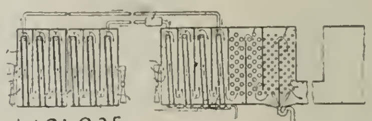
1,131,852



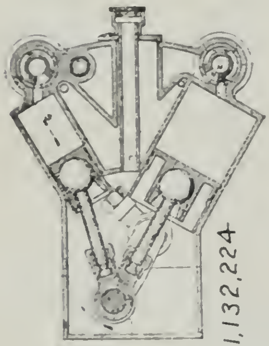
1,132,188



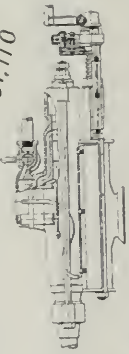
1,131,968



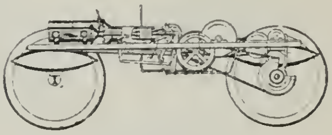
1,131,835



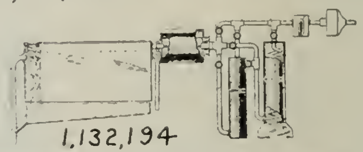
1,132,224



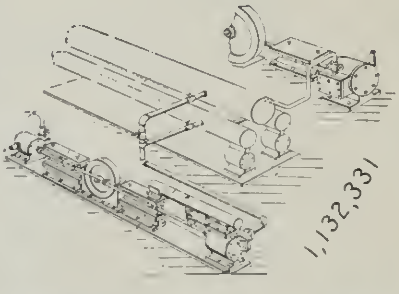
1,131,110



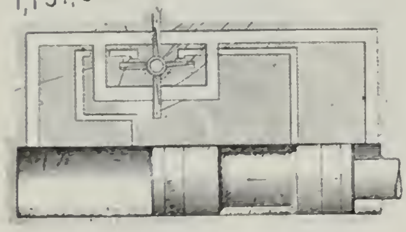
1,131,913



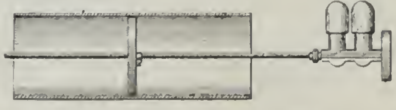
1,132,194



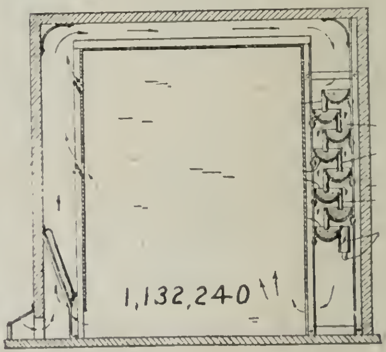
1,132,331



1,131,812



1,131,762



1,132,240

Pneumatic Patents March 16.

1,131,309. MANUFACTURE OF GASOLENE. Raymond F. Bacon, Benjamin T. Brooks, and Clinton W. Clark, Pittsburgh, Pa.

1. The method of producing from petroleum oils which have a boiling point of 250° C. and upward, a mixture of hydrocarbons boiling below 200° C., which consists in subjecting the petroleum oils treated to a combined cracking and distilling operation at a temperature within the range of 350° C. to 500° C., and at a pressure within the range of 60 lbs. to 300 lbs. per square inch, progressively removing from the heating zone the particles of tar and coke produced therein and depositing them out of contact with the walls of said heating zone; substantially as described.

1,131,391. PNEUMATIC-MOTOR FOR PIANO-PLAYERS. Joseph Leisch, Tryon, N. C.

1,131,401. CLUTCH MECHANISM. John G. MacPherson, Philadelphia, Pa.

3. The combination of a clutch having relatively movable engaging members, a spring normally tending to force said members into engagement, a second and stronger spring opposing the action of the first spring, and fluid pressure actuated means for nullifying the effect of the second spring.

1,131,577. AIR-COMPRESSOR. Charles Wainwright, Erie, Pa.

MARCH 16.

1,131,762. AIR-PROPELLER. William N. Whipple, Syracuse, N. Y.

1,131,812. VALVE-MOTION FOR PNEUMATIC TOOLS. Robert Lunnan Ambrose, Easton, Pa.

1,131,835. APPARATUS FOR DEHYDRATING AND WARMING AIR. Gordon Don Harris, Bay Shore, N. Y., and James S. Pollard, Bayonne, N. J.

1,131,852. PNEUMATIC SYSTEM OF MINING COAL AND REMOVING FOUL GASES FROM MINE-CHAMBERS. Edmund C. Morgan, Chicago, Ill.

1. The combination with a mining machine, of a pneumatic flue extending from said mining machine, and means for automatically lengthening said flue continuously as the said mining machine moves forward and in accordance with such forward movement.

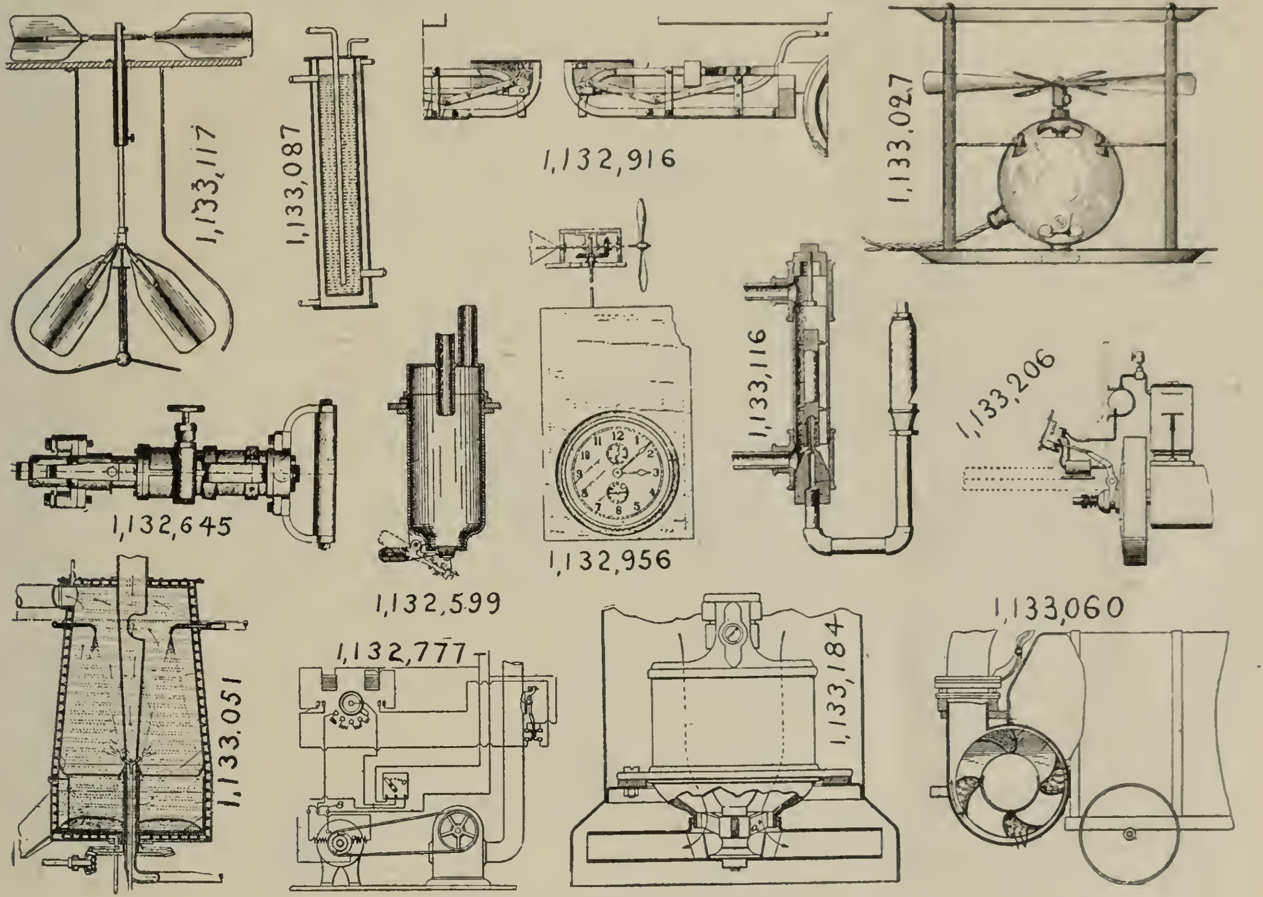
1,131,913. COMPRESSOR-AIR MOTOR-MACHINE. Charles Cooper, Kansas City, Mo.

1,131900-67-71. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,131,994. EXPLOSIVE CONTAINING LIQUID AIR OR OXYGEN AND LAMPBLACK. Georges Claude, Paris, France.

1. An explosive cartridge comprising liquid air or oxygen, and lamp black having a density of about 0.23 to 0.26 permeated by said liquid.

2. An explosive cartridge comprising a mixture of lamp black having a density of about 0.23 to 0.26 and napthalene and liquid air or oxygen permeating said mixture.



Pneumatic Patents March 23.

3. An explosive cartridge comprising a mixture of lamp black having a density of 0.23 to 0.26 and napthalene constituting from 5 per cent. to 25 per cent. of the mixture, and liquid air or oxygen permeating said mixture.

1,132,110. AUTOMATIC WORK-REGISTER. George R. Murray, Cleveland, Ohio.

1. A register of the class described, comprising counting means, and operating means therefor arranged to be operated by a movable member of a fluid-pressure-actuated machine to which the register is applied, such operating means comprising fluid-pressure-controlled power-transmitting means adapted to be connected to the source of supply of fluid pressure for such tool or machine, and arranged to disconnect the counter from such operating means during idle periods.

1,132,188. FLUID-MOTOR. Hugh W. Kimes, Dayton, Ohio.

1,132,194. APPARATUS FOR DEHYDRATING OR DESICCATING AIR FOR INDUSTRIAL PURPOSES. Francisco Garcia P. Leao, New York, N. Y.

1,132,224. STARTER FOR INTERNAL-COMBUSTION ENGINES. Gregory John Spohrer, East Orange, N. J.

1,132,237. COMBINATION-BLOWER. Harold A. Bierck, Philadelphia, Pa.

1,132,246. AIR-CONDITIONING SYSTEM. Louis M. Du Commun, Cleveland, Ohio.

1,132,276. ROCK-DRILL. Vilhelm P. Kessel, San Francisco, Cal.

1,132,331. AIR-COMPRESSING APPARATUS. William Charles Gebhardt, San Antonio, Tex.

1. An air compressing and air storing apparatus, comprising a low pressure container provided with means for connecting it with apparatus to be driven, a high pressure container, an engine driven by compressed air from the high pressure container, a compressor drawing air from the atmosphere operated by said engine and compressing air into the low pressure container, and a compounder operated by said engine for forcing air under increased pressure into the high pressure container.

MARCH 23.

1,132,599. MILKING-MACHINE. Ernest L. Mills, Watertown, and Richard M. Mills, Cicero, N. Y.

1,132,649. PNEUMATIC TOOL. Benjamin Brazelle, St. Louis, Mo.

1,132,650. VENT-REGULATOR FOR PNEUMATIC ACTIONS. Melville Clark, Chicago, Ill.

1,132,777. AUTOMATIC PRESSURE-CONTROLLER. Chester S. Jennings, Brookline, Mass.

1,132,916. AUTOMATIC BRAKE-PIPE COUPLING. Desire Dorso, Vancouver, British Columbia, Canada.

1,132,956. DEVICE FOR UTILIZING WIND-POWER. Paul Medved, Milwaukee, Wis.

1,133,027. VENTILATING APPARATUS AND METHOD. Peter Cooper Hewitt, New York, N. Y.

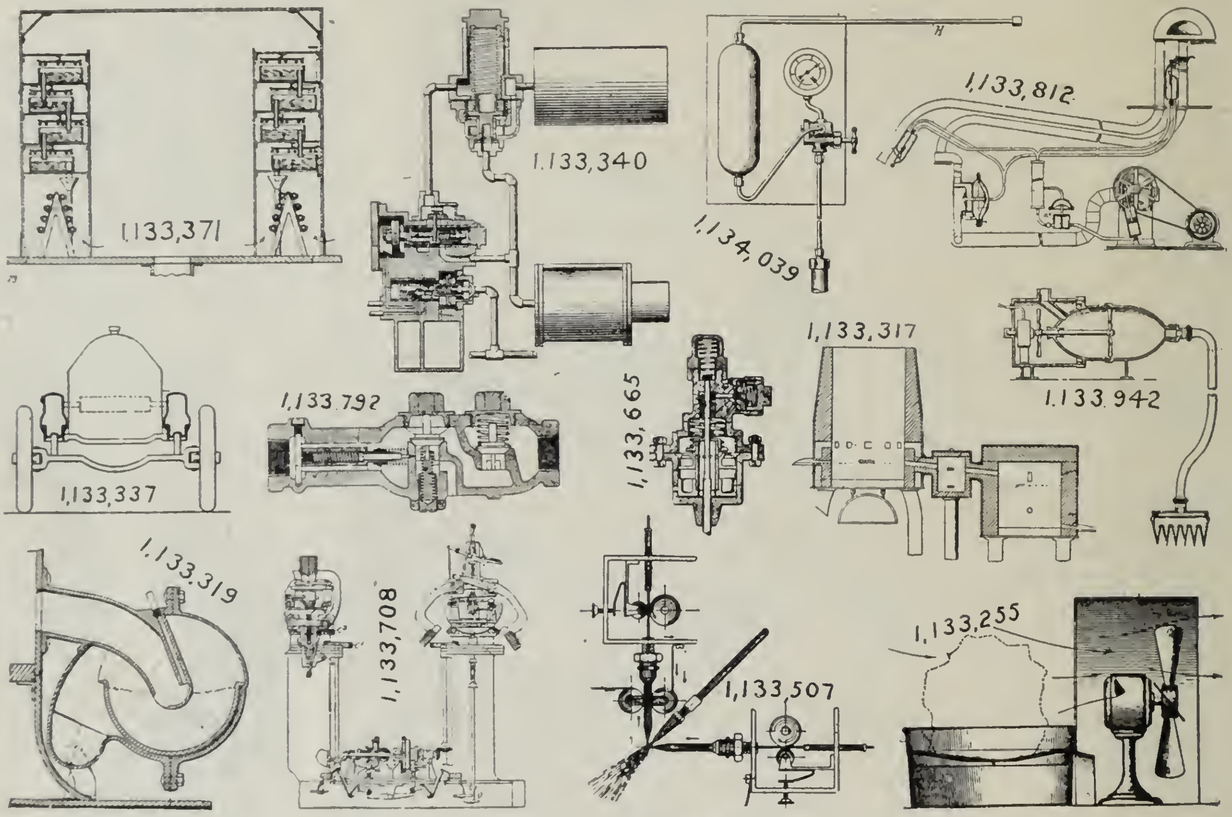
1,133,051. METHOD OF DESICCATING. Irving S. Merrell, Syracuse, N. Y.

1. The method of desiccating organic liquids containing a high moisture content which consists in spraying the liquid into a chamber in which a high degree of vacuum is maintained, injecting into said chamber highly superheated steam, the temperature of the steam being sufficiently high so that it will not condense within the chamber at the minus pressure maintained therein, and preventing condensation within the chamber by heating the walls thereof.

1,133,060. PNEUMATIC STACKER. Victor Nelson Perry, Batavia, N. Y.

1,133,087. PURIFICATION OF HYDROGEN. Carl Bosch and Wilhelm Wild, Ludwigshafen-on-the-Rhine, Germany.

1,133,116. AIR-SIGNAL VALVE. Edward Joseph Ericsson, San Francisco, Cal.



Pneumatic Patents March 30.

1,133,117. AIR-MOTOR FOR FANS FOR RAILROAD-CARS. Gaetano Festa, Revere, Mass.

1,133,184. SUCTION APPARATUS. Friedrich Roemer, Frankfort-on-the-Main, Germany.

1,133,206. PNEUMATIC CLUTCH CONTROL. Rufus W. Welty, San Francisco, Cal.

MARCH 30.

1,133,255. APPARATUS FOR COOLING OR AGITATING AIR. Herman E. Baumgartner, Osage, Iowa.

1,133,257. PNEUMATIC ACTION. George P. Brand, New York, N. Y.

1,133,269. PRESSURE-ALARM FOR PNEUMATIC TIRES. George A. Culver, Beatrice, Neb.

1,133,317. METALLURGICAL APPARATUS. Charles J. Rice, Ashland, Ky.

1. A cupola furnace adapted to contain a bath of molten metal, main twyers arranged therein above the bath of metal, means for supplying air at relatively low pressure thereto, and high pressure purifying twyers fitted in the furnace below the main twyers and above the level of the top of such bath and inclined downwardly and having means for suplying air at relatively high pressure thereto to cause the high pressure blasts therefrom to penetrate the bath.

1,133,319. COMBINED GRAVITY AND FLUID-PRESSURE SANDER FOR LOCOMOTIVES. Edwin A. Rives and Harrison B. Nabors, Greensboro, N. C.

1,133,337. PNEUMATIC-CUSHIONED FRAME SUSPENSION. Guy L. Tinkham, Paris, France.

1,133,340-1. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,133,371. AIR-CONDITIONING SYSTEM. Louis M. Du Commun, Cleveland, Ohio.

1,133,507-8. APPARATUS FOR SPRAYING MOLTEN METAL AND OTHER FUSIBLE SUBSTANCE. Max Ulrich Schoop, Zurich, Switzerland.

1,133,537. NUT-LOCKING DEVICE FOR AIR-COMPRESSORS. Nelson T. Cline, McKees Rocks, Pa.

1,133,543. VACUUM-CLEANER. John J. Duffie, Berkeley, Cal.

1,133,644-5. TRIP-VALVE DEVICE FOR AIR-BRAKES. Ernest Rowland Hill, East Orange, N. J.

1,133,708. GLASS-BOTTLE-BLOWING MACHINE. Albert Edward Clegg, Leeds, England.

1,133,764. GLASS - BLOWING MACHINE. Charles E. Volk, Erie, Pa.

1,133,792. UNLOADING DEVICE FOR COMPRESSORS. Herbert W. Cheney, Milwaukee, Wis.

1,133,793. PNEUMATIC PIANO-ACTION. Robert W. Cooper, Dayton, Ky., and Frank A. Lee and Ray J. Meyer, Cincinnati, Ohio.

1,133,812. PNEUMATIC-DESPATCH-TUBE APPARATUS. James G. Maclaren, Harrison, N. Y.

1,133,942. BARBER'S DEVICE. Antonio Di Salvio, Washington, Pa.

1,134,039. TORPEDO-TESTING APPARATUS. William Dieter, Brooklyn, N. Y.

1,134,070. SEALING-MACHINE. Robert Magrane, New York, N. Y.

COMPRESSED AIR
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Vol. XX JUNE, 1915 No. 6

DRILLS AND DRILL BITS

BY CHARLES A. HIRSCHBERG.

In the early days of rock drilling a machine drill was considered satisfactory so long as it was capable of more rapid work than the man-and-single-or-double-jack." Subsequently as the possibilities of machine drilling were better understood, the demand on the drill became more and more exacting, until its manufacture has reached that final stage of perfection where it may be said to be no longer a question of further improvement of the drill design, but rather one of a better understanding of methods of handling, drilling the round and sharpening the drill steel.

Each has an important bearing, but it is the purpose in this article to deal only with the last mentioned phase of the question. The problem is at best a complex one, involving a study of the nature of the rock to be drilled; the method of attack or drilling round; the temper of the drill bit; the number of teeth or cutting edges: their shape and pitch.

The ground may be of a heterogeneous nature, of shattered formation, or of varying degrees of hardness, each creating a different problem, requiring special study to select the type of drill bit that can be employed most effectively. In other words, the degree of familiarity with the rock will determine largely the adaptability of the different types of drilling bits—hence the ultimate degree of efficiency to be secured from the drilling machine, irrespective of its type, style of mounting, or handling. However, it should not be overlooked that some types of drills have inherently higher drilling speed than others; therefore, maximum piston speed combined with the proper cutting bit will give the utmost cutting speed.

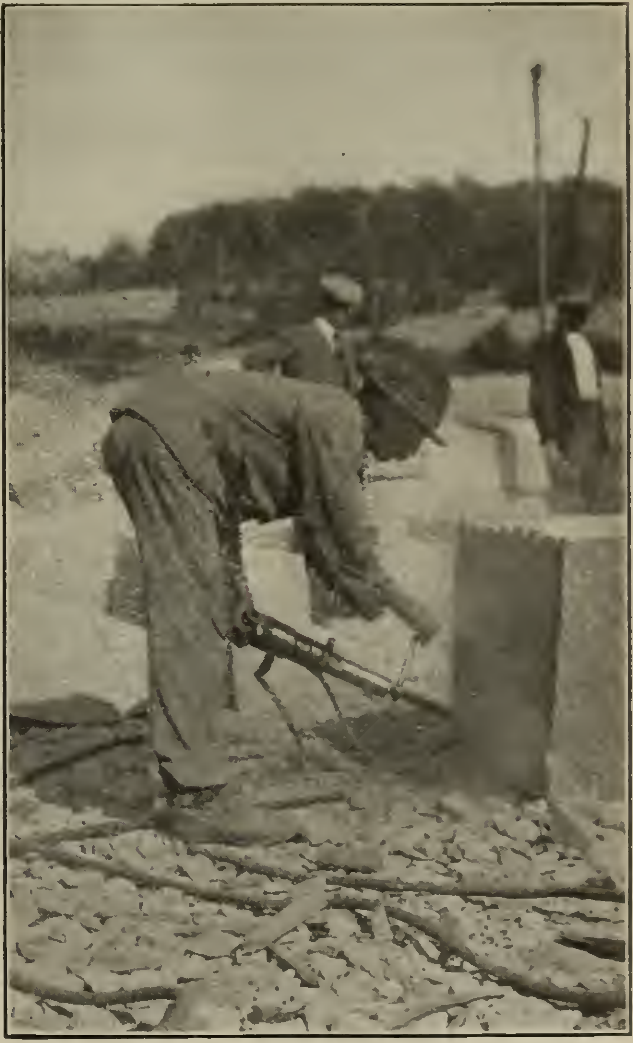


FIG. I. HAND ROTATED DRILL.

Therefore, greatest drilling efficiency depends upon the following factors:

(1) Knowledge of the rock.

(2) The selection of a machine drill that is suitable for the work in hand: whose dead time in handling and mounting is low, and that is capable of keeping pace with the drill bit.

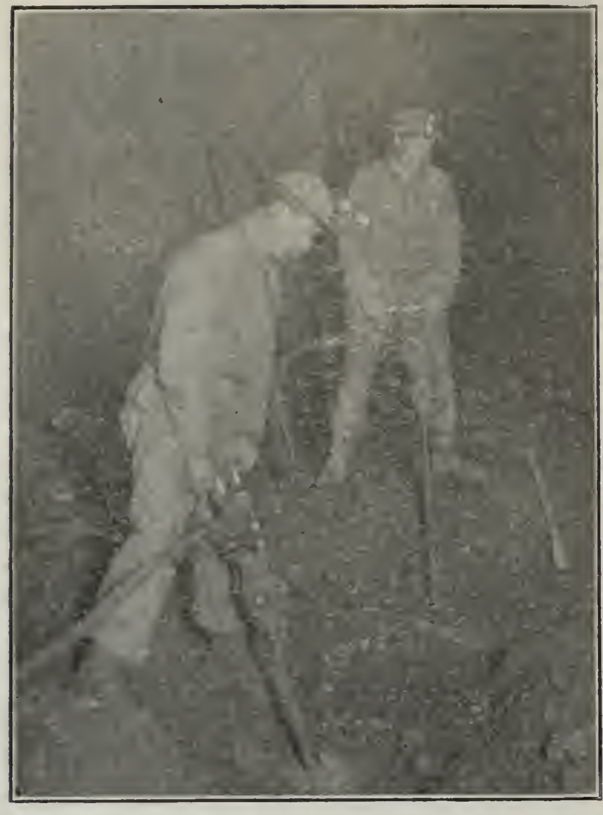


FIG. 2.

(3) A study of suitability of drill bit.

TYPES OF DRILLS.

Hand-Hammer Class.—This class divides itself into two distinct types, the "hand-rotated" or plugger drill, and the "self-rotated" or Jackhamer drill.

Hand-Rotated.—Experience has shown that the "hand-rotated" drill (Fig. 1) is being confined to the drilling of comparatively shallow holes such as that required by "plug-and-feather" work, pop-shooting, etc., and even in this class of work it is rarely ever used where other requirements make it necessary to employ the "self-rotated" drill for other work.

The points in favor of the "hand-rotated" drill are: (1) Extreme lightness and absence of mounting. Weight ranges from 20 to 50 lbs. (2) Low air consumption. (3) Lower first cost. This generally is the determining factor with the small operator.

"Self-Rotated" — Jackhamer Type.— The "self-rotated" drill (Figs. 2 and 3) is used extensively for the drilling of down holes in shafts, trenches and road work, for taking up bottom, tunnel trimming, etc., and its record of performance is remarkable, as will be noted from some of the figures quoted further on.

The points in its favor are also: (1) Lightness and absence of mounting; weight ranges from 40 to 90 lbs., although lately machines have been developed and placed on the market weighing as little as 18 to 20 lbs. (2) Low air consumption. (3) Automatic rotation, relieving the operator of unnecessary labor. (4) Some effective hole-cleaning device is generally provided. (5) Rapid drilling.

SOME JACKHAMER RECORDS.

A few accomplishments are cited in the following: In the shaft of the American Zinc Co. an average of five Jackhamer drills sank a total of 284 ft. in 13 weeks, the drilling, shooting and mucking being started on Monday and completed on Thursday; the balance of the week being devoted to timbering. .Size of shaft was 7x22 ft. Weekly average footage 21.9.

In one of the hoisting shafts of the Houston Colleries Co. at Carswell, W. Va., Walter F. Patterson, Jr., contractor, sank 253 ft. with three machines of this type during the period, starting March 2 and ending June 8. Weekly average footage was 18, which includes time timbering. Size of shaft overall was 24 ft. 4 ins. by 16 ft. 4 ins.

In the shaft of the Butte Alex. Scott Copper Co. at Butte, Mont., 101 ft. were sunk in 89 shifts with two such drills. Size of shaft was 7x14 each of two compartments. The upkeep expense in this case was but $2 per month per machine.

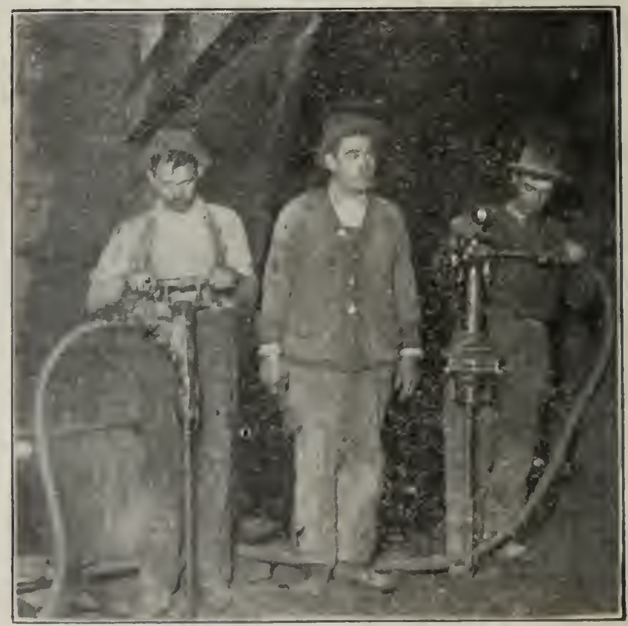


FIG. 3.

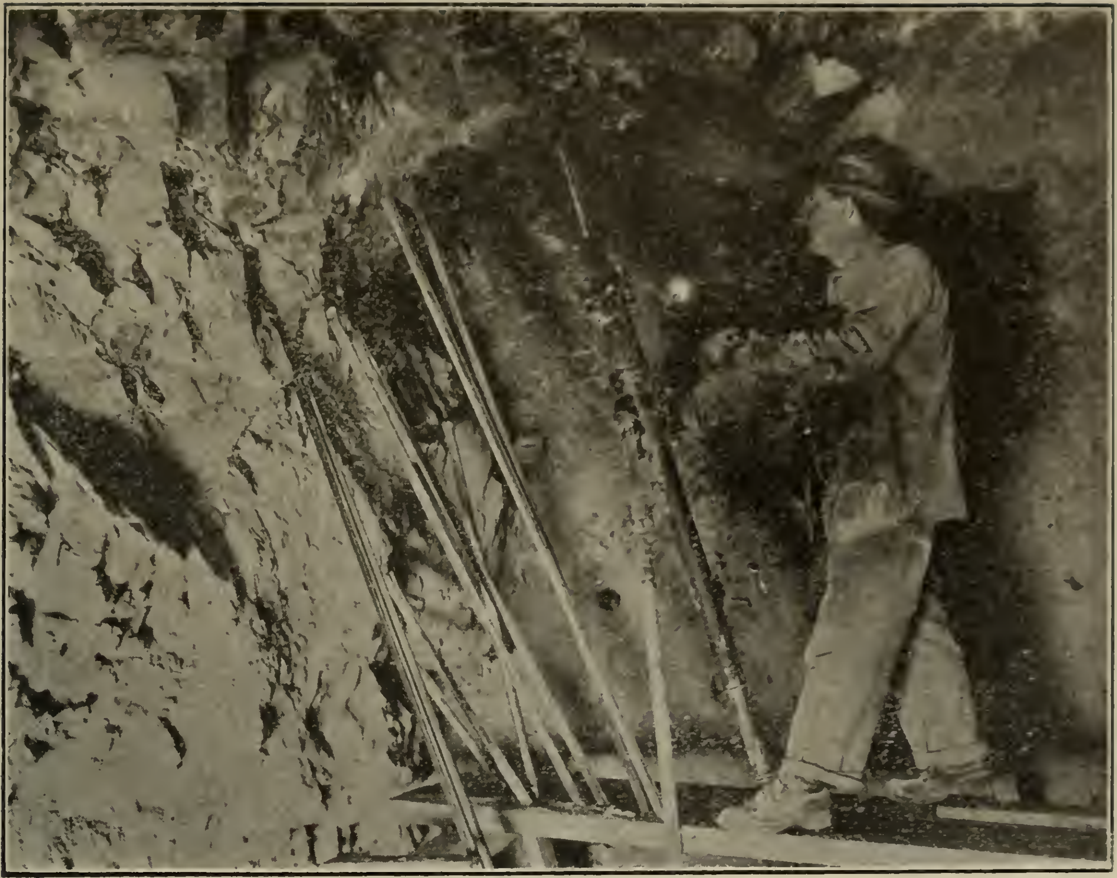


FIG. 4.

These performances are remarkable when compared with work accomplished with tripod drills which were formerly employed in this class of work.

Stoper Drill.—This type of machine (Fig. 4) for raising and stoping may be said to have a field distinctively its own. It is self-feeding up to the rock and is built both in "hand-rotated" and "self-rotating" types. Experience with the latter type has been comparatively recent.

The advantages of this type of drill for the work mentioned are: (1) Absence of mounting and ease of operation. (2) Rapid drilling. (3) It may be worked in very close quarters.

The record of accomplishment with the stoper drill in its special field has been all that could be desired. A few typical cases follow:

STOPER DRILL RECORDS.

One of the large Lake Superior mines recently drove 400 lineal feet of raise in a total of 50 shifts with two stopers operated by one man each. This work consisted in driving four raises of 100 ft. each. The ground was sufficiently hard so that timbering was not necessary other than occasional sprags by

FIG. 5.

means of which the men got to the working places.

In a test recently conducted on the Port Richmond tunnel job, California, a stoper averaged 70¾ ins. of drill hole in 19½ minutes.

The following case gives an opportunity for comparison between machine stoping and hand work covering a period of 3½ months in a total of 313 drill shifts: There were 16,431 ft. of hole drilled with four Butterfly drills, or an average of 52½ ft. per machine per day. The total cost during this period including wages of drill men, blacksmiths, timbering, blasting and a compressor man, and such miscellaneous supplies as coal, oil, gasoline and lighting was $3458.34 (Mexican currency), giving a unit cost of 10¼ cts. gold per foot of hole. The records of the company show that two operators with one double jack averaged 10 ft. of hole per day, for which a contract price was paid of 30 cents, gold per foot.

Mounted Hammer Drills.—In that class (Fig. 5) the market affords but one type—the "Leyner-Ingersoll" drill (excepting that lately the Jackhamer has been used mounted, for flat hole work), which has been successfully adapted for drifting and tunnelling, and as it represents a distinct departure from the generally accepted types of mounted machines a little historical sketch may not be out of place.

LEYNER DRILL HISTORY.

The Leyner drill was invented by J. Geo. Leyner, of Denver, Colo., and was the result of considerable experiment on his part, dating as far back as 1895, at which time he was manufacturing a reciprocating piston drill similar to that on the market at the present time.

There were several factors that induced Mr. Leyner to devote all his energies to the development of a successful hammer drill, in spite of the opposition which he knew would have to be met owing to the long prevailing usage of piston drills. One of these was the realization of the ultimate need for a light, easily handled and yet rapid drilling machine. His experience told him that this combination was not to be found by following prevailing designs, in spite of the fact that the experiments of other inventors with the hammer type of drill had not proved successful.

So far as the author is able to learn Mr. Leyner was the first inventor to adapt water to the drilling of rock through the medium of the machine itself, although the first Leyner hammer drill did not embody the water feature. The justification for Mr. Leyner's adherence to the conviction that the hammer drill has advantages that cannot be offered in any other type is shown by the widespread use of this drill.

Briefly its advantages are: (1) Ease of handling, mounting and chucking steel. (2) Rapid drilling for comparatively deep and large diameter holes. (3) The laying of the dust by means of the water feature and the admission of air and water to the bottom of the drill hole for cleaning purposes. (4) The permissibility of using it in close quarters.

The record of accomplishment is a long and successful one. An idea as to this may be gained from the following cases:

LEYNER DRILL RECORDS.

In a tunnel 12 ft. wide by 7½ ft. high carrying a drainage ditch 4 ft. wide by 2 ft. deep, driven for the Locust Mountain Coal Co., at Shenandoah, Pa., by Dolan Bros., contractors, a progress of 259 ft. was made in the first 14 days of October last, working three 8-hour shifts per day, and using two Leyner drills in sandstone—the last 14 days working in hard conglomerate rock, the progress was 254 ft. It will be noted that the hardness of the rock did not make much difference in the progress as the drills did practically as much work in both 14-day periods.

In the Cleveland Cliffs Iron Co.'s mines, the figures over a considerable period of time show 12 tons broken per man with this type of drill, as against 7 tons with a 3-in. piston drill.

In the Davidson Ore Mine Co.'s mine, working in iron ore, the average footage per drill is 117 ft., as compared to 59 ft. formerly obtained with a 2¾-in. piston drill.

The following are some of the tunnel jobs on which Leyner drills have been used and the highest progress attained in any one month on each job:

The above work represents practically every kind of conditions and rock encountered in tunnel and drift work.

ABOUT DRILL BITS.

With each type of drill mentioned in the foregoing, hollow steel is employed, and in the following are described some of the special conditions that have been met by certain de-

Name of Tunnel.	Location.	Size.	Highest Monthly Advance.
Central	Colorado	6'x9'	222 ft.—26 shifts.
Elizabeth Lake	California	12'x12'	604 ft.
Hot Time	Colorado	5'x7½'	263 ft.—with 1 drill.
Joker	Colorado	12'x11'	282 ft.—2 drills.
Laramie Poudre	Colorado	8'x10'	653 ft.
Lucania	Colorado	8'x9'6"	263½ ft.—29 shifts.
Newhouse	Colorado	6'x9'	290 ft.—30 shifts.
Rawley Drainage	Colorado	7'x8'	555 ft.—26 days.
Raymond	Colorado	9'x9'	169 ft.—24 shifts.
Roosevelt Drainage	Colorado	10'x6'	435 ft.
Santa Barbara	California	6'x7'	439 ft.
Locust Mountain	Pennsylvania	12'x7½'	513 ft.
Snake Creek	Utah	6'x9'4"	371 ft.
Rogers' Pass	British Columbia	7'x9'	851 ft.—31 days.

TUNNELS WHERE LEYNER DRILLS WERE USED.

partures from the standard drill bit practice:

Self-Rotating Hand Hammer Drill Operated by Steam.—In such work as shaft sinking in loose cavey material, some operators have experienced trouble due to the choking up of the hole in the steel and have employed the following means for overcoming the difficulty: A standard 6-point bit was altered as shown in Fig. 6. The hole in the steel, instead of being carried directly through the center of the bit, was punched through the side about ⅝ to ¾ in. above the cutting edge—the bit itself being forged solid, the hole coming out between the wings.

The clearance of the bit was also increased by cutting out the metal between the wings, back to the base of the bit or to the normal diameter of the steel. This reconstruction of the 6-point bit permitted it to accommodate itself to the water of condensation and mudding effects. Still another bit that was found of great service in almost identical conditions of drilling was a "V" shaped bit as shown in Fig. 7. The cutting edges consisted of two straight edges, meeting at a point and open at one side similar to a "V," the metal between these cutting edges being cut well back and the hole carried straight down.

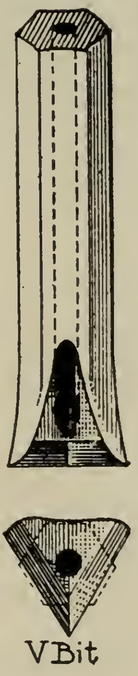


FIG. 7.

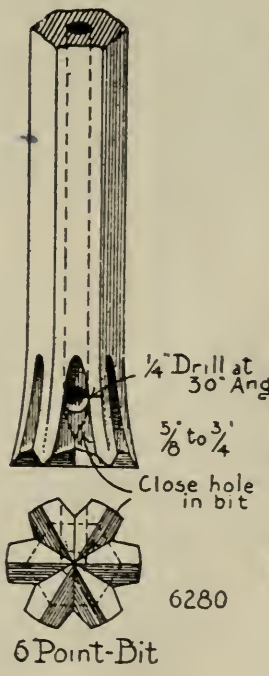


FIG. 6.

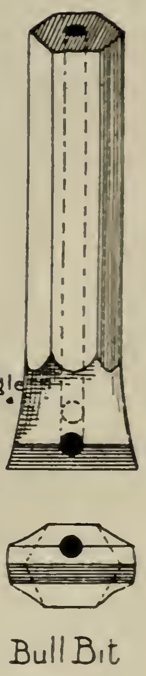


FIG. 8.

Another illustration of the value of a bit specially created for the job is demonstrated in the sinking of a shaft in Colorado through sand rock and blue shale. This ground was found to give particularly bad mudding and had a tendency to cement. Various bits were tried and while it was found that the ordinary form of chisel bit with a single cutting edge gave satisfactory results, further experiments led to a change consisting of carrying the hole in the steel out at the side (Fig. 8) instead of through the end. With multiple cutting edge bits it was found that the steel would jam in the hole and a great many holes and steels were lost, whereas the chisel or flat bull bit could readily be removed and drilled equally as fast in this rock.

James A. McIlwee in commenting on the results obtained by him with Jackhamers in the sinking of a shaft in Utah, stated, that if machines of this class are not mudding properly the difficulty can often be overcome if the operator will occasionally raise the machine and steel so that the bit is about 6 ins. from the bottom of the hole; this will permit the air to blow through the steel and remove the mud from the bottom of the hole. Especially in drilling deep holes was this practice followed. He found that the "rose" or 6-point bit was a failure in this shaft, whereas a cross 4-point bit with a liberal clearance between wings turned the trick. The ground in this case was hard quartzite, and it was necessary to temper the steel in cyanide of potassium so as to protect the corners.

In further commenting on this job Mr. McIlwee stated: "We used four machines in sinking this shaft 500 ft. We had a 6-way manifold on the end of the air line, one for the pump, four for the drills and one for a blow pipe. An extra hose with a small ½-in. blow pipe 6 ft. long was kept in the shaft at all times, and when the holes were being drilled through ravelly ground, and the machines refused to throw the mud out, we would take the drill out and send the blow pipe to the bottom and give the hole a blowing out. By doing this for every 12 to 18 ins. we easily drilled 7-ft. cut holes."

The Use of Blunt Steel.—In the southwest there are a great many self-rotating hand-hammer drills operating by steam, in soft rock, and occasional trouble was experienced until a suitable bit had been found. In one very puzzling case where the rock was a very soft lime stone, 6-point bits were at first tried, but as satisfactory results could not be obtained, the standard 4-point cross bit was resorted to, and while considerable improvement was noted, it was felt that the results could be improved upon. The cross bits were made and then blunted to retard the cutting action and this successfully solved the problem. In rock as soft as that in question, sharp 6 and 4-point bits drill too rapidly, causing the cuttings to wedge around the steels just above the bits and interfere with rotation.

In drilling out an old concrete foundation containing about 2000 cu. yds. of material, the practice followed by a contractor was as follows: Holes were drilled to a depth of 30 to 36 ins. about 15 ins. apart, 15 ins. from the edge, 10 to 12 holes in a row. Two feet half-round feathers about ¼ in. thick were used and a 4-ft. pointed steel wedge about 1¼ ins. thick was driven into each of the holes drilled and slabs of concrete broken off. The wedges were driven in all at one time by men with sledges. Drilling was all done without change of steel and no special starters were employed. In starting this work "rose" bits were at first used, but as it was found that fragments of concrete and pebbles would wedge between the wings of the bit, and interfere with the free rotation of the drill steel; cross bits with broad exit passages between the wings were resorted to.

In the shaft of the Butte-Alex. Scott Copper Co. which was driven through hard and almost dry granite, 18 to 22 holes, 5 to 6 ft. deep, were drilled in 3½ to 4 hours' time, including the time consumed blowing holes out and blasting, and during March of this year, 101 ft. of shaft was broken, although operations were not conducted during 17 shifts of the month. Here difficulty was experienced in keeping the hole in the steel open, and the same method resorted to as that already described to overcome the difficulty. The hole was drilled in the hollow steel at a point 2 to 3 ins. above the end of the bit, and the mining company states that they are able to drill 7-ft. holes, and but very seldom experience trouble from plugged steels.

Punching the Hole in the Side of Hollow Steel.—Fig. 9 shows the manner in which the hole is punched in the side of hollow-drill bits and the style of punch used in doing the work. The punch if dressed as shown at the top makes the job easy of accomplishment and insures the closing of the hole in the end

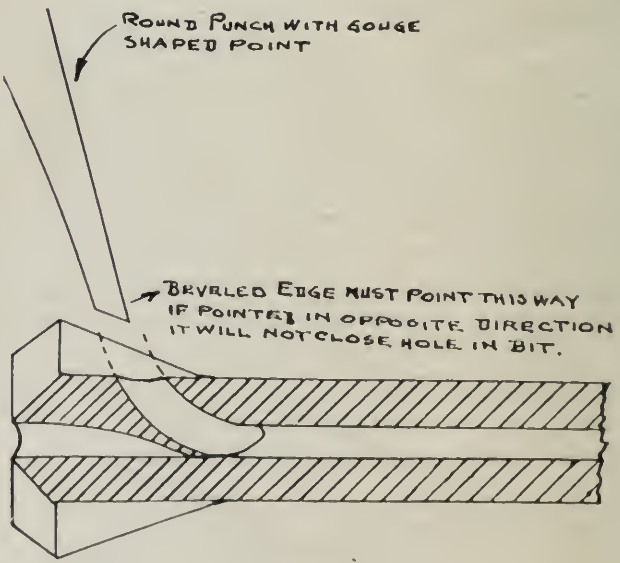

ROUND PUNCH WITH GOUGE SHAPED POINT
BEVELED EDGE MUST POINT THIS WAY IF POINTED IN OPPOSITE DIRECTION IT WILL NOT CLOSE HOLE IN BIT.

FIG. 9.

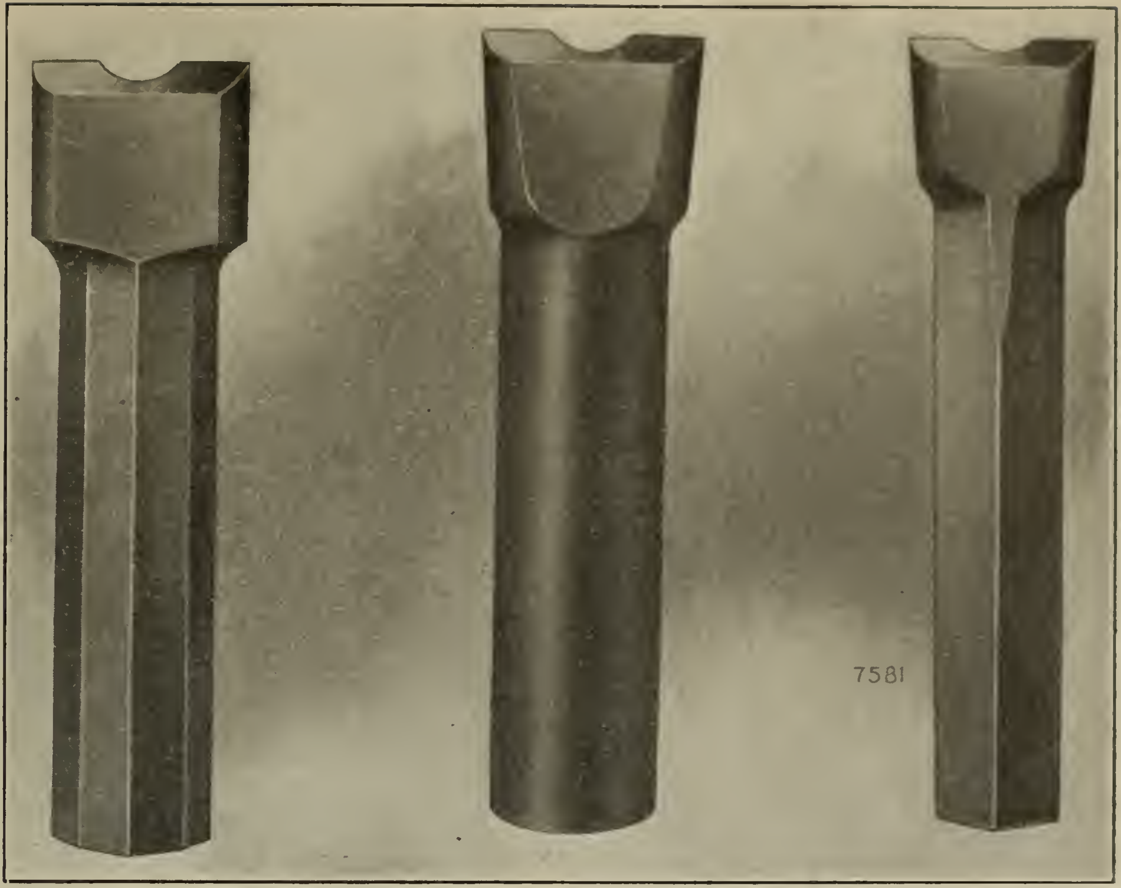


FIG. 10. FIG. 11 A. FIG. 11 B.

of the bit. The hole is punched part way and the punch withdrawn and cooled in water. It is then inserted once more and becomes sufficiently heated by the time it reaches the natural hole in the steel to take on a slight curvature. The beveled edge of the punch leads it into the hole as shown, forcing the metal just forward into the hole that leads out the end.

THE CARR BIT.

A recent contribution to the solution of the drill bit problem is that of the Carr bit. (Patents owned by the Ingersoll-Rand Co.) This bit while designed primarily for overcoming certain difficulties in drilling rock, has been found to meet satisfactorily, not only these special conditions, but the ordinary conditions as well. The Carr bit (Fig. 10) has but a single cutting edge and is uniform and symmetrical in shape. A transverse recess is formed across the center of the bit. With hollow steel this recess is tapered until it runs into the original hole through the steel. With solid steel the recess extends back about ½ in. from the face. This recess tends to act as a pilot, and reduces the cutting or contact surface with the rock to a minimum. The thickness of the bit is made equal to the short diameter of the steel and the length equal to the bit gauge. Hollow drill steel bits are conical in shape and have a 5° taper on a side (Figs. 11, 11A and 11B). Solid steel have straight, parallel, cylindrical sides (Figs. 10 and 12).

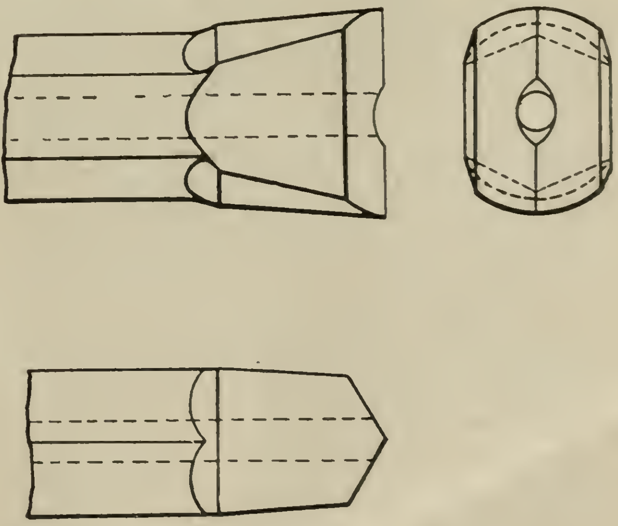


FIG. 11.

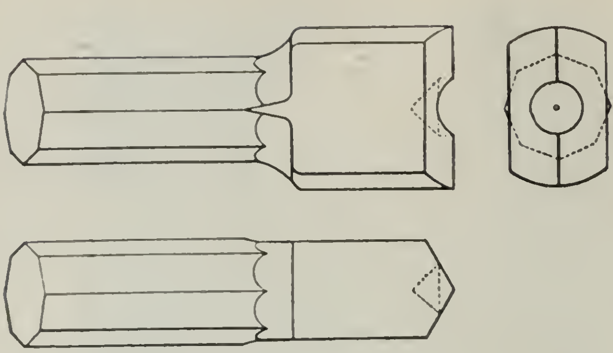


FIG. 12.

The advantages claimed for the Carr bit are: It holds its gauge better than the bits familiar to the trade; thereby increasing the depth to which a hole may be drilled before having to change steels. This reduces the number of steels dulled per shift. It drills a round hole and rotates easily. It does not require more than 1-16-in. variation in the gauge of bits on successive lengths of steel, thus avoiding the use of large diameter bits and therefore reducing the amount of rock to be cut. The bit is very simple in form and very easily made, either with hand tools or in the patented Leyner sharpener equipped with Carr dies.

The record of experience shows cases where holes have been drilled with a single Carr-bitted steel to a depth of 16 ft. through very hard rock, with soft seams running almost parallel with the hole being drilled, but with pitch enough to cross the line of the hole at a bad angle. The size of bit used was 1¾-in. on 1¼-in. round, hollow steel, and lost but very little of its gauge.

The idea of drilling a hole the same size from the collar down to the bottom originated with the inventor, from the discovery that a drill bit cuts a margin of clearance for itself, so that the problem became one of designing a bit that would effectually resist loss of gauge, would drill a round hole and cut rapidly.

To insure the drilling of a round hole the shape of the bit was made such that it would be imposible for it to go down if the hole were not round. The next problem was to overcome the loss of gauge. This was done by providing the long shoulders curved concentric with the axis of the bit. This combined with the other feature necessary in drilling the round hole formed a large area on the shoulders. The hole being round, and the bit being round, it simply rotates in the hole like a shaft in a boxing. Rapid cutting speed was assured by forming the tranverse recess in the centre of the bit, for the purpose of reducing the area that comes in contact with the rock.

After the above had been done, it was discovered that the harder the blow delivered to the steel and transmitted to the rock, the larger would be the hole cut by the bit. This was overcome by making the bit more blunt, or with less cutting edge pitch, and it was then discovered that the blunt bit would cut faster than the sharper pitch, as it would reduce the rock in the bottom of the hole by crushing a larger area and absorbing absolutely all of the blow to advantage, as there would be no slipping or sliding off of knots or lumps in the bottom of the hole.

A test of the Carr bit by the Alaska Treadwell Gold Mining Co. with a Bull Moose type of Jackhamer, as against the cross bit with the same machine, showed about 20 per cent more drilling for the Carr bit, while on the regular Jackhamer the Carr bit did about a third faster drilling than did the Cross bit under identical conditions.—*Mining World.*

AIR BLASTS IN MICHIGAN MINES

In our issue for January, 1912, page 6303, attention was called to the recurrence of violent and damaging "air blasts" in some of the deep copper mines of Michigan, especially the Quincy. It was assumed that these occurrences were due to the sudden displacements of large volumes of air, caused by the falling of great areas of the unsupported hanging walls in the old workings. Some doubts were suggested as to whether or not this dropping of the rock was the initial cause. Some of the shocks accompanying the blasts might be characterized as local earthquakes, the tremors in some cases having been noticed at distances of several hundred miles.

This matter is revived in the report of Mr. Charles L. Lawton, general manager of the Quincy mine, for the year 1914, and what follows is reproduced from that report.

On March 25, air-blasts occuring throughout the mine continued intermittently for a week or ten days. As a consequence, various crosscuts and drifts were crushed and closed up. No. 6 shaft-timbers were seriously crushed between the 51st and 58th levels, and No. 2 shaft was crushed and closed between the 40th and 50th levels.

About 500 ft. of the crushed section of No. 2 shaft had to be entirely recovered and re-timbered at an expense nearly as great as that of sinking a new shaft. In the remaining portion of the damaged shaft, about half of the timbers were replaced. Excellent work was done, and a speed record made in recovering the shaft in the months of April, May, and June.

Below the 50th level, the shaft was not damaged by the air-blasts, though the cross-cuts at the 57th, 64th, 65th, and 66th levels were entirely closed, and the levels north were badly crushed. The 67th, 68th, 69th, 70th, and 71st levels north and south were not injured. The shaft has been entirely repaired and is now in good physical condition.

It was necessary to employ a considerable force of men for several months to renew and repair a large proportion of the timbers in the crushed section of No. 6 shaft, and to strengthen it by filling the old adjacent stopes with rock, while keeping the shaft in constant operation, in re-opening cross-cuts and drifts that were crushed, and in re-opening and re-timbering No. 2 shaft. Thus the cost of production was increased very much during the month following the air-blasts, especially because of the loss of three months' product from No. 2 shaft, and consequently the impossibility of operating the mine, railroad, and stamp-mills as economically at about 65% capacity.

In earlier days, when air-blasts were little understood, it was the custom to stope-out the lode irrespective of the shaft. If the lode was rich in copper, it was stoped-out close over or under the shaft; where the shaft was in the lode, the latter was stoped right up to the shaft without leaving shaft-pillars. Going through the upper portions of No. 2 and No. 6 shafts, is like going down through open stopes, with practically no pillars left to protect the shafts. It was in the lower part of these sections that the caving and crushing took place, with such serious results.

For several years there has been a rigid adherence to the policy of leaving increasingly larger shaft-pillars as the shafts are sunk, in order to sustain the litho-static pressure about the shafts. The air-blasts have never caused any damage to these sections of the shafts. At the present bottom of the mine, these pillars are being left 200 ft. each side of the shaft.

Air-blasts have continued with more or less frequency since July, though they have not damaged or retarded the work to any great extent. There were but three fatal accidents during the year, involving less than one-fourth of 1 per cent. of the working force.

In order to meet the air-blasts and prevent as far as possible the damages caused by them, as fast as the mining in each stope is finished, the bottom of the stope along the back of the level is filled with poor rock, constituting what is termed 'rib work.' Experience has taught that these rock-packs are the most effective means yet employed to lessen the damage caused by air-blasts.

After a careful investigation and study of the effects of the series of air-blasts that occurred in 1906, rib-work was employed for the first time throughout what were then the lower workings of the mine to combat the damages caused by these disturbances. For a number of years these rock-packs proved effective until the series of 1909. Again careful investigation and study readily showed that the rib-work was along proper lines, but had not been carried far enough. Therefore the packs were made deeper in the stopes, that is, doubled in size. For a still longer period of time these rock-packs proved sufficient, until March 25, 1914, when another series of air-blasts occurred. For the third time in has been shown that the rock-packs proved to be the best means of limiting such damage.

In order, however, that the highest effectiveness possible may be secured within the limits of profitable mining at greater depth, this rib-work should be still further strengthened. It is estimated that the voids in the rock give it a shrinkage of about 20 per cent. at the present depth of the mine. In order to lessen this shrinkage and strengthen the rib-work, the question of filling the voids with bank-sand, stamp-sand, or crushed rock is receiving serious consideration, inasmuch as provision must be made for better and stronger supports to the back of each level, as fast as stoping is finished. This must be done so as to avoid extended crushing, and thus guard the safety of the employees, minimize the losses and expenses caused by air-blasts, and make permanent the mine's future operations with depth.

During the year, $57,190 was spent for the recovery of the shafts and levels that were damaged by the air-blasts, and $21,487 has been expended in the fight toward preventing damages by air-blasts.

SOME JACKHAMER SUCCESSES IN ROCK DRILLING

BY CHARLES C. PHELPS

[The following article was first printed in the special "Success" issue of *Coal Age*, April 3, 1915, ED. C. A. M.].

Three years ago the Jackhamer was unknown to the American coal miner. Today thousands of these little tools are in use in all branches of the coal industry—development work, shaft-sinking, stripping, driving gangways and cutting out seams of coal. They are also performing a multitude of other operations requiring the drilling of rock or coal. In this brief interval the Jackhamer has established for itself an enviable reputation in both the anthracite and bituminous fields as a mining tool of exceptional utility and efficiency.

It is probable that the miner first came to appreciate the value of the Jackhamer in connection with shaft-sinking. Some of its best records have been made in work of this character, and it is now looked upon as almost a necessity for this purpose. It works close up to the walls, keeping the shaft true to the required dimensions. It starts to operate without delay, whereas, in a crowded shaft, the mounted type of drill probably requires as much time to set up and adjust as is needed for the actual cutting. The steady rotation of the steel, the rapid blows on the drill and the constant blowing of the exhaust through the hollow steel, which keeps the drill hole free of cuttings, all tend to produce rapid penetration and to avoid troublesome delays.

SUNK 61 FEET OF SHAFT IN 17 DAYS

The records of performance best illustrate the successful achievements of the Jackhamer. A few typical cases follow. At the Bellevue Mines of the Delaware, Lackawanna & Western R. R. Co. coal department, Mike Hoban, a contractor, sunk 61 ft. of shaft of dimensions 12x14 ft. in hard sandstone rock in 17 days, working three 8-hr. shifts daily and using only one Jackhamer. This machine was in almost continuous operation, averaging 280 ft. of hole drilled per shift.

Dolan Bros. recently sunk a shaft 15x16 ft. at the mine of the Lytle Coal Co., near Minersville, employing two Jackhamers for that purpose. In four months' time, working through ground varying from very hard material to slate, they sunk 359 ft. of completed shaft, including timbering. There were three 8-hr. shifts per day and six days' work per week. These contractors say: "We have sunk many shafts of this approximate size with mounted piston drills, but never made the progress we have made in this one." The progress in the case cited figures to about 90 ft. per month. Their best previous record, using other types of drills, was about 61 ft. per month. They evidently entertain hopes of exceeding even this figure, for they state further: "If we had installed a sharpener at this job when we started it, instead of sharpening by hand, we believe we would have exceeded this footage."

SHAFT COMPLETED IN THREE MONTHS AND ONE WEEK.

Another interesting report is from Walter F. Patterson, Jr., of Pittsburgh, Penn. He sunk a shaft at the Houston Collieries Co.'s operation at Carswell, W. Va. The size of the shaft for the first 18 ft. was 30 ft. 4 in. by 22 ft. 4 in. Below that level it narrowed to 24 ft. 4 in. by 16 ft. 4 in., and continued with those dimensions till it reached the bottom at 253 ft. The monthly progress was as follows:

March, 1914	96 ft. excavation, 58 ft. timbering
April, 1914	86 ft. excavation, 53 ft. timbering, 1 water ring
May, 1914	54 ft. excavation, 109 ft. timbering, 1 water ring, 270 cu.yd. concrete
June (8 days)	17 ft. excavation, 33 ft. timbering, 4 strings, guides, brattice and stairs

Three Jackhamers were employed per shift on an average.

The weekly average was 18 ft. of completed shaft.

IN STRIPPING WORK STEAM CAN BE USED AS FURNISHED BY SHOVEL.

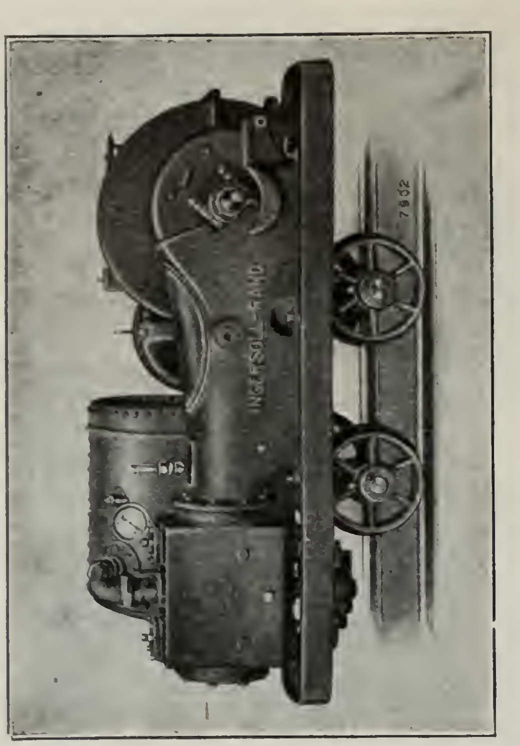
In all of the work previously referred to, the Jackhamers were operated by compressed air. They work almost equally as well on steam. This feature is particularly desirable in coal stripping, as the Jackhamers can be run by steam furnished by the steam shovel used in stripping. During some observations on the use of steam-operated Jackhamers for coal stripping in Kansas the operator drilled 14 one-foot holes in the sandstone cap rock in 20 min. In the coal bed, which is 4 ft. thick, several 4-ft. blast holes were drilled, the average time for completion being 3 min. each, whereas it required an average of 20 to 30 min. to accomplish the same result by hand. The exhaust steam kept the hole as clean of cuttings as if compressed air had been employed.

HOUSTON COLLIERIES CO.'S SHAFT AT CARSWELL, W. VA.

USING THE HAMMER DRILL IN AN ELECTRICALLY OPERATED MINE.

The development of the electrically driven mine-car compressor has greatly broadened the field of usefulness of pneumatic coal-mining machines for underground operations and this applies especially to the Jackhamer.

Several other electrically equipped mines are adopting the same method for drilling blast holes in both rock and coal. It is a simple matter to move such units from place to place in a mine wherever they may be needed. They are run over the regular mine tracks, derailed wherever desired and placed to one side. It is a simple matter to connect them up electrically, and they require little atten-



MINE CAR COMPRESSOR.

tion to operate, being self-regulating, self-lubricating and having a hopper type of water-jacket that requires refilling only at intervals of several hours. The compressed air leaves the compressor in a somewhat heated state, which is a source of economy and avoids all necessity for a reheater.

SERVES WELL FOR DRILLING COAL.

There is scarcely a substance known that the Jackhamer will not penetrate with ease—from the hardest granite to the softest coal. The same steel may be used for penetrating different materials, although larger-diameter steels are usually employed in drilling coal. "The Jackhamer is capable of driling in either coal or rock, which makes it a much handier tool around a mine than the ordinary coal auger," writes W. B. Earnest, of Cordova, Ala., who has been using the Jackhamer in the Indian Head Mines.

He continues: "It is so far ahead of the coal auger as to make the odds ten to one. In using this Jackhamer drill you do not know when you strike a sulphur ball, whereas with the coal augers you readily know it, as you will have to replace your auger because the points break when the sulphur ball is encountered." In boring coal for blasting Mr. Earnest uses a 6-ft. steel with a bit of large diameter and runs it straight in without changing steels and without any support for the Jackhamer other than the hands of the operator.

TWO FEET OF HOLE PER MINUTE IN HARD COAL.

In the St. Clair Division of the Philadelphia & Reading Coal & Iron Co. the Jackhamer was observed to drill very hard coal at the rate of 2 ft. of 2-in. hole per minute, using twisted steel and a 1¾-in. sheep-nose bit. This type of bit worked without raising any dust, which was particularly appreciated by the drill runners.

In telling of its experiences with the Jackhamer the Rex Coal Co., of Kitts, Ky., states: "We have a hard sandstone top and with this drill we can put up a 6-ft. hole in from 15 to 18 min. Before we got this drill we were paying $4 per yard for entry work; now we pay $1.75 and drill the rock, which makes a total cost of less than $2 per yard. The Jackhamer is the finest thing we have ever seen in the way of a drill. One man operates it and doesn't use any support for it at all."

DRILLS WITHOUT MOUNTING.

The few cases cited in the foregoing paragraphs will enable one to appreciate the reasons for the success which the Jackhamer has achieved in coal mining. The ordinary mounted drill would be quite out of the question for drilling blast holes in coal, for more time would be wasted in setting it up than in drilling. The Jackhamer, on the contrary, can be kept cutting nearly one hundred per cent. of the time if desired. For the same reason it has supplanted the mounted type of drill for cutting rock and is used for this purpose in many coal mines.

It strikes many hundred blows per minute, which is the principal reason for its great cutting speed. It is a popular tool with the miners not only because it enables them to increase their production but also because it is an easy matter to manipulate it. Weighing only 40 lb., it is as easy to use in drilling a "flat" as in sinking a "down" hole; and in fact it is occasionally used for drilling "up" holes. The Jackhamer requires little physical effort on the part of the runner, as it is merely necessary to apply it to the desired spot and guide is as it cuts. The Jackhamer drill is manufactured by the Ingersoll-Rand Co., of New York City.

A GAS ENGINE DRIVEN NATURAL GAS COMPRESSOR

One of the most interesting of the many engineering features of a natural gas transmission system is the compressor station, where the pressure of the gas is raised sufficiently high to furnish the desired volume to the most distant point of distribution. Experience early demonstrated the natural or rock pressure of the wells in gas fields to be unreliable under variable ranges of consumption and weather conditions. So in order that an adequate supply may be always at hand over the entire system under wide ranges of consumption, it is necessary that the pressure throughout the lines be maintained constant and uniform. This is done by putting the gas through compressor cylinders, and the type of machine now generally used for this purpose is shown in the half tone on this page.

This compressor consists of a gas engine with gas compressing cylinders directly connected to the front end of the bed. It is one of three units of the same general type in the plant of the Medina, Ohio, Gas and Fuel Co.'s compressor station, at Mansfield, Ohio. The Medina Company obtains is gas from the Ashland and Wayne County (Ohio) gas fields, and supplies a number of cities, including Mansfield, Lima and St. Mary's, and intermediate towns along its 150 miles of main trunk lines. More than 22,000 customers are supplied over the entire territory covered by the company's distributing system. No expense has been spared in the equipment of the compressor station and the distributing system to provide every possible safeguard for the protection of their customers against shortage or shut-off of gas supply.

The gas engines were built by the C. & G. Cooper Co. of Mt. Vernon, Ohio. This construction of driving the compressor cylinders direct coupled to the engine piston rods at the front end of the engine beds has become an accepted standard in compressing work.

The station contains two single tandem engines of the horizontal double-acting type, having cylinders of 21½" diameter and 36" stroke, each rated at 480 brake horse power; also one twin tandem engine having the same size cylinders, rated at 960 brake horse power when operating at 125 revolutions per minute.

The compression is accomplished in two stages. The twin tandem drives two 30¼

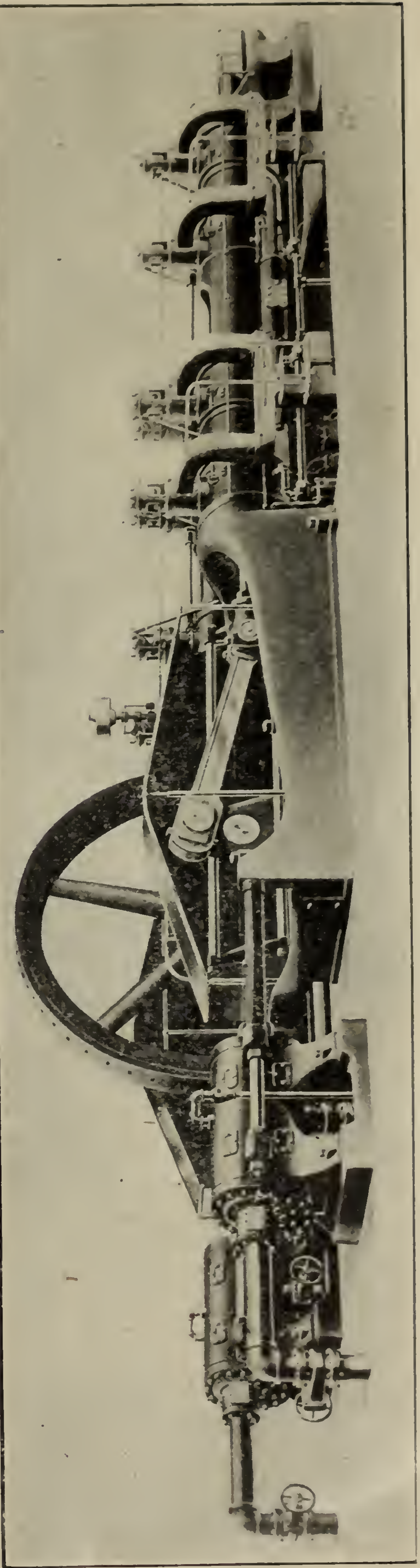


FIG. I.

hurricane type Ingersoll-Rand cylinders, which compress the gas through the first or low pressure stage. These cylinders are designed to deliver about 15,000,000 cubic feet of free gas per 24 hours at 10 lbs. suction pressure, and deliver the gas to the second or high pressure stage, at about 60 lbs. pressure. The two single tandem units each drive a 15¾" high pressure Hall compressor cylinder, which receives the gas from the low pressure stage at about 60 lbs. pressure, and discharges it to the pipe line at about 200 lbs. pressure. The two cylinders have a combined capacity of about 12,000,000 cu. ft. of free gas per 24 hours.

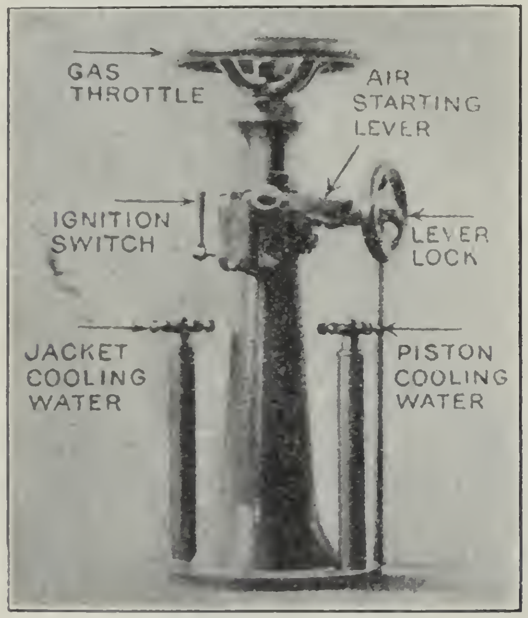


FIG. 2.

The simplicity of starting and stopping these machines is a feature. Fig. 2 shows the floorstand throttle or operating center. The gas, the air-starting and the water valves, as well as the ignition switch, are all located on this stand. To start the engine it is only necessary to open the compressed air valve which "cranks" it. The gas valve is then opened, and as soon as ignition takes place in the cylinders, the pressure air automatically is replaced by the regular explosive mixture, and the air starting valve automatically is thrown out of service when the air valve on the throttle stand is closed. Two valves on the floor stand throttle control the water circulation, one the jacket cooling water which passes first through the exhaust valve chambers, then through the cylinder jackets and out to the overflow pipe. In the latter system, after passing through the cylinder heads, the water enters the piston rods at the intermediate cross-head, flowing in opposite directions, and passing out through outlets provided at the main and rear crossheads. This arrangement of cooling serves to maintain uniform temperatures in each cylinder, each piston rod and each piston. The gas and air piping is arranged so as to provide a stairway and platform for the convenience of the operator in inspecting and oiling the inlet valves and gear.

TESTING THE SENSITIVITY OF DYNAMITE

A question having arisen recently between a mining company and a powder company regarding the quality of the gelatin furnished, the manufacturer sent a representative to investigate. A test of the sensitiveness of the powder was conducted as follows: A stick of the gelatin was cut in halves and into one half was inserted a cap and fuse. A paper tube was made by rolling a piece of ordinary letter paper about the stick so that the two halves were 12 in. apart end to end, after which the fuse was lighted. The explosion of the primer-half did not explode the other half of the stick but blew it about 15 or 20 ft. away and left it frayed up and looking like a sponge. A second stick was similarly cut, rolled and fired, the distance between the two ends being 5 in. The result was practically the same. A third stick was cut and similarly fired, the two ends of the cut stick being 2 in. apart, and in this instance the primer half exploded the other half of the stick.

This test proved to the mining company that the gelatin was no good, inasmuch as it was so insensitive to shock that half a stick of the powder with a strong detonating cap would not shoot off another stick of the same gelatin until it was within 2 in. of it. The test proved to the powder representative that the powder was all right, because if it would explode a stick 2 in. away from it, it certainly would explode a stick touching it, which would be the case in a loaded drill hole. Thus was demonstrated the sensitiveness of the powder to detonation, the sensitiveness of the manufacturing company to criticism, and the sensitiveness of the mining company to conviction. —*Mining Journal.*

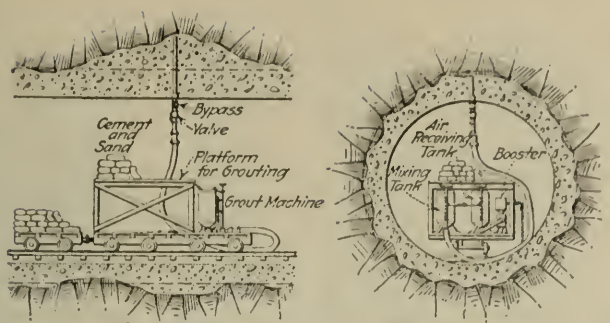


FIG. 1 COMPRESSED-AIR DRIVEN BOOSTER

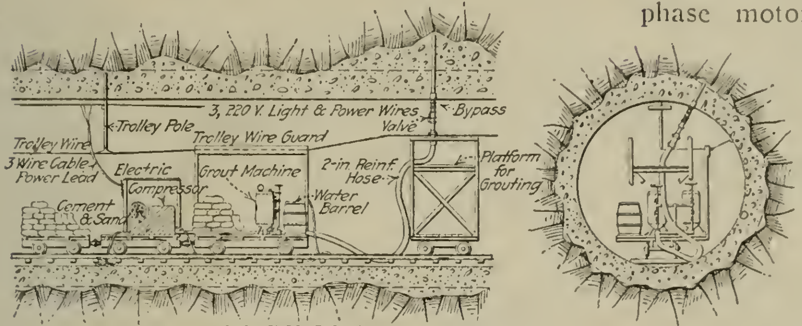


FIG. 2 ELECTRIC-DRIVEN COMPRESSOR

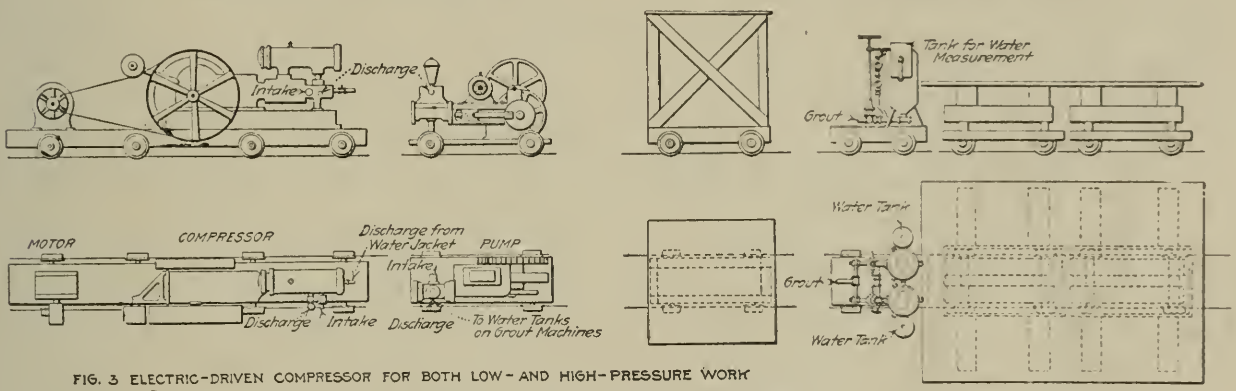


FIG. 3 ELECTRIC-DRIVEN COMPRESSOR FOR BOTH LOW- AND HIGH-PRESSURE WORK

COMPRESSOR AND GROUTING OUTFIT.

DIFFERENT COMPRESSORS AND GROUTING OUTFITS FOR CATSKILL AQUEDUCT

BY WALTER E. SPEAR.

The accompanying illustrations show the equipment employed in grouting the City Tunnel of the Catskill Aqueduct. Fig. 1 shows the arrangement of plant commonly used on the Catskill Aqueduct, which was adopted in some sections of the City Tunnel. Air piped from the compressor plant on the surface was delivered directly to the grout tanks at pressures of 80 to 100 lb. per sq. in. for the low-pressure work. When the grouting required higher pressures the air was further compressed to 200 or 300 lb. per sq. in. by means of an auxiliary air-driven compressor or "booster," supplied from the compressor at the surface.

On several sections of the City Tunnel compressed air was furnished for the grouting by small electrically driven compressors mounted on trucks in the tunnel and moved along with the work. Fig. 2 shows a type of equipment in which the low-pressure grouting was carried on as usual with the air furnished from the surface compressor plant, but the high-pressure grouting was done with the small compressor driven from the lighting or power circuits.

Still another style of equipment is shown in Fig. 3. Here a 20-hp. Westinghouse three-phase motor drives a two-stage Ingersoll-Rand belt driven compressor at 210 r.p.m., delivering 129 cu. ft. of air per min. at a pressure of 350 lb. per sq. in. A 7½ hp. motor of the same type as the larger one drives a double acting geared McGowan pump, delivering 50 gal. of water per min.

With this plant both the low-and high-pressure grouting was done with the electrically driven compressor in the tunnel. The adoption of this equipment, in which the compressor in the tunnel could be operated only when grouting was actually being done, made unnecessary the more or less continuous operation of the large compressor plant on the surface and effected a further economy in avoiding the piping of compressed air through the tunnel for the grouting work.—*Engineering News.*

The International Signal Company has brought out a device that automatically reduces train speed to any desired rate whenever a train approaches a switch or crossover, gives a short, sharp signal audible to crew and passengers, and automatically stops a train entering a block that is not clear.

SAND BLAST CONDITIONS FOR EFFICIENCY

BY JAMES M. BETTON.

No sand blast can work at best efficiency without an ample supply of compressed air carried at an even and steady pressure. The air must be free from oil and moisture, which will otherwise condense on the sides of the sand tank, run down and cake the sand about the sand valve besides, especially in the case of oil, clogging the air pipes.

The quantity of compressed air consumed by any sand blast is only the amount that is delivered through the nozzle, barring leakage. The size of the air inlet to the sand blast does not modify this, the quantity of air used is that which finally issues from the nozzle mixed with the sand. This applies to any make of sand blast.

The horsepower required to compress 100 cubic feet of free air from atmosphere to the various pressures, with one-stage compression, is given in Table I.

TABLE I

Gage pressure, pounds.	Actual horse-power.	Gage pressure, pounds,	Actual horse-power.
2	0.93	55	12.67
5	1.96	60	13.41
10	3.60	70	14.72
15	5.03	75	15.37
20	6.28	80	15.94
25	7.42	85	16.50
30	8.47	90	17.06
35	9.42	100	18.15
40	10.30	125	21.00
45	11.14	150	24.00
50	11.90		

No allowance is made for friction of air in compressor or piping, for which 15 to 20 per cent. should be added.

To ascertain the power required to supply any sand blast with compressed air under a given pressure, multiply the quantity of air, in cubic feet, discharged per minute from a nozzle of the diameter selected, under the stated pressure, by the actual horsepower required to compress 100 cubic feet of free air, as shown, and add 20 per cent. for friction. This is worked out in Table II, which gives the quantity of air discharged through nozzles of various diameters under the usual limits of working pressures, 20 per cent. being added for friction.

HOW THE SAND WORKS.

Regulate the flow of sand into the current of air so that just enough will issue from the nozzle to give a good cutting effect. The sand cleans an object by striking an infinite number of sharp blows on a small area, and not by the friction of the particles sweeping over it. Just enough sand will enable each grain to get in good work. Too much will cause the particles of sand to rub on one another and reduce their energy by the friction of their particles.

As a rule, hold the nozzle about 6 inches from the surface to be cleaned, at an angle of from 30 to 45 degrees. Use coarse sand in preference to fine, for general cleaning. It does quicker work with less dust and breaks into smaller particles which can be used again. Dry all sand over a fire, either on an iron plate, stirring continuously, or in a sand-drying stove. Sand that contains any moisture cannot be depended upon to flow from the sand tank by gravity. Do not use sand that contains clay, loam or burnt sand, all of which cause unnecessary dust in the cleaning room. Clay and loam can be washed out of the original sand, if better cannot be procured, and burnt sand sifted out by a double-decked screen. All sand should be run through a No. 8 mesh screen before being placed in the sand tank. Stones, chips, shells, leaves and paper will surely clog the nozzle and interrupt the blast, unless they are removed.

Make the air piping between the air receiver and the sand blast as short and direct as possible. Do not reduce it below the size the air connection calls for and, if the distance is over 75 feet, make it at least one size larger. This reduces the friction of the air in the piping and gives a volume of air behind the sand blast. Keep the air piping tight and protect it from the cold if it is exposed, preventing condensation. If the air is damp when it reaches the sand tank, use a moisture separator near the tank, or trap out the moisture from the bottom of a U-shaped bend.

If a pressure-reducing valve is used to cut down the air pressure in the sand blast, put a small air receiver in the air line, between the reducing valve and the sand blast, to give a good body of air behind the blast, as well as to condense moisture. Keep the pressure reducing valve clean and free from pipe scale inside, to obtain best results.

The air compressor should be of sufficient capacity and power to supply freely the quantity of air discharged by the sand blast nozzle under the selected pressure, and to maintain this pressure evenly. When you have determined the quantity of air needed, buy a compres-

TABLE II

CUBIC FEET OF FREE AIR DISCHARGED PER MINUTE BY SAND BLAST NOZZLES, WITH HORSEPOWER REQUIRED FOR OPERATION—20 PER CENT ADDED FOR FRICTION

Single Stage Compression at Sea Level

†Horsepower.
*Free air.

Diam. nozzle, inches.		Gage pressure, pounds.														
		2	5	10	15	20	25	30	35	40	45	50	60	70	80	90
⅛	*	2.435	3.86	5.45	6.65	7.70	8.60	10.00	11.20	12.27	13.40	14 50	16.80	19.00	21.20	23.5
	†	0.026	0 09	0 24	0.40	0.58	0.77	1.02	1.26	1 51	1.79	2.06	2.70	3.35	4.06	4 8
3/16	*	5.45	8.72	12.30	15.00	17.10	19.40	22.40	25.00	27.40	30.40	32.80	37.50	42.90	47.50	52.4
	†	0.06	0.20	0.53	0.90	1.33	1.73	2.27	2.82	3.42	4.04	4.68	6.03	7.57	9.08	10.7
¼	*	9.74	15.40	21.80	26.70	30.80	34.50	40.00	44.70	49.00	53.80	58 20	67.00	76.00	85.00	94.0
	†	0.11	0.36	0.94	1.60	2.32	3.07	4.05	5.05	6 05	7.19	8.31	10.77	13.40	16.26	19.2
5/16	*	16.18	24.12	34.00	41.75	48.25	54.00	63.00	70.00	76.75	84.00	91.00	105.00	119.00	132.50	147.0
	†	0.18	0.56	1.46	2.50	3.64	.4.80	6.41	7.90	9.50	11.23	13.00	16.90	21.00	25.34	30.0
⅜	*	21.95	34.60	49.00	60.00	69.00	77.00	90.00	100.00	110.50	121.00	130.00	151.00	171.00	191.00	211 0
	†	0.24	0.81	2.11	3.62	5.20	6.90	9.14	11.30	13.65	16.20	18.60	24.30	30.00	36.50	43 2
½	*	39.00	61.60	87.00	107.00	123.00	138.00	161.00	179.00	196.40	215.00	232.00	268.00	304.00	340.00	376.0
	†	0.43	1.44	3.75	6.45	9.26	12.24	16.30	20.16	24.24	28.70	33.10	43.10	54.00	65.00	77.0
⅝	*	61.00	96.50	136.00	167.00	193.00	216.00	252.00	280.00	307.00	336.00	364.00	420.00	476.00	532.00	587.0
	†	0.68	2.27	5.87	10.00	14.54	19.20	25.61	31.70	37.90	44.90	52.00	68.10	84.00	101.70	120.0
¾	*	87.60	133.00	196.00	240.00	277.00	310.00	362.00	400.00	441.80	482.00	522.00	604.00	685.00	765.00	843.0
	†	0.97	3.13	8.46	14.50	21.00	27.60	36.70	45.20	34.60	64.40	74.70	97.20	121.00	146.40	173.0
⅞	*	119.50	189.00	267.00	326.00	378.00	422.00	493.00	550.00	601.30	658.00	710.00	823.00	930.00	1,004.00	1,145.0
	†	1.33	4.44	11.53	19.67	28.50	37.60	50.00	62.10	75.50	89.00	101.40	132.00	164.00	192.00	234.0
1	*	156.00	247.00	350.00	427.00	494.00	550.00	645.00	715.00	785.40	860.00	930.00	1,070.00	1,215.00	1,360.00	1,500.0
	†	1.74	5.81	15.10	25.80	37.20	50.00	65.50	80.80	102.00	115.00	132.80	172.00	215.00	260.00	308.0

sor of about double this quantity. The additional quantity will be very quickly utilized in your work and the first cost will not be unreasonably greater. You will not regret doing this. You cannot get the air receiver too large.

For large nozzles, ⅜-inch, ½-inch, ⅝-inch or ¾-inch diameter of bore, the air pressures of 20 to 40 pounds, use 1½-inch hose at least. For pressures 45 to 80 pounds use ¾-inch delivery hose and ¼-inch nozzle. This size hose is easier to handle, does not fatigue the operator as much as a larger size and the highest velocity of the mixed air and sand is maintained. Do not kink or bend the hose to shut off the sand. It destroys the hose very quickly fills the tube with solid sand, which, with the power required to eject it, is wasted as far as working effect is concerned. If this were not the case, every sand blast would be provided with a shut-off valve at the nozzle end of the hose.

NOZZLES.

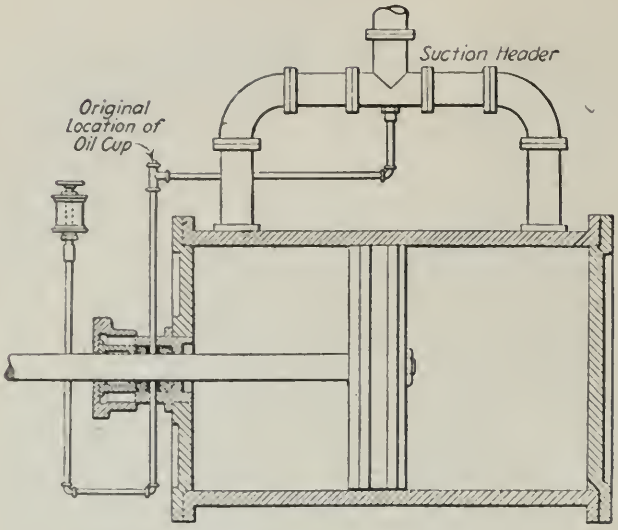
All nozzles will wear, some faster than others, and no nozzle has yet been made that will stand up to this severe work for any length of time. The material of which a nozzle is made makes very little difference in the rapidity of its wear. All wear too quickly. A short nozzle wears better usually than a long one in which the sand eddies from side to side, expending valuable energy in wearing out the containing tube.

As the nozzle wears, the consumption of air increases very rapidly, for which reason it is not good economy to continue to use a nozzle that is worn much beyond the original bore. Valuable power is easily wasted in this manner and a compressor closely calculated for given work may easily become overworked. Change the nozzle when its outlet becomes appreciably greater than the original bore and save the air. A cylindrical nozzle never wears at the point of entrance but always at the outlet end. A disc nozzle, on the contrary, wears on the inlet side and not at the outlet, hence the volume of air consumed always remains constant and the pressure steady.

Make the cleaning room as simple and as light as possible. Admit light from above when possible. Make the floor of steel sheets to retain the sand and have all walls tight and protected from the flying sand.

Make the dust outlet near the floor, in the wall opposite the door and connect to it an ample exhaust fan. The dust will then be drawn down and away from the worker's face and the fan suction may be increased to a point at which the dust is always kept away from him. Admit fresh air through door. Locate the cleaning room so that the castings may come to it in regular order. Save steps and time.

Put the sand blast in charge of an intelligent workman who understands the machine and elevate the work from a "job" to a department, giving due credit for prompt, quick and clean work. The sand blast is as important and useful a tool in the shop as a lathe, drill, planer, grinder or other machine tool and will save its cost when properly located and handled. The sand blast requires dry air under proper pressure and dry sand to give satisfactory results. The sand must flow from the sand tank. You cannot ram it through.—*The Foundry.*



SHOWING CHANGE IN OIL PIPE.

LUBRICATING COMPRESSOR PISTON ROD

The stuffing-boxes on two ice machines in a small refrigerating plant gave considerable trouble. Unless three or four times as much oil as is usually needed was supplied, the rods would either run hot or leak and the packing would soon wear out. It was difficult to keep engineers for a time after the plant was started and most of them kept out of trouble with the ammonia rods by using excessive quantities of oil.

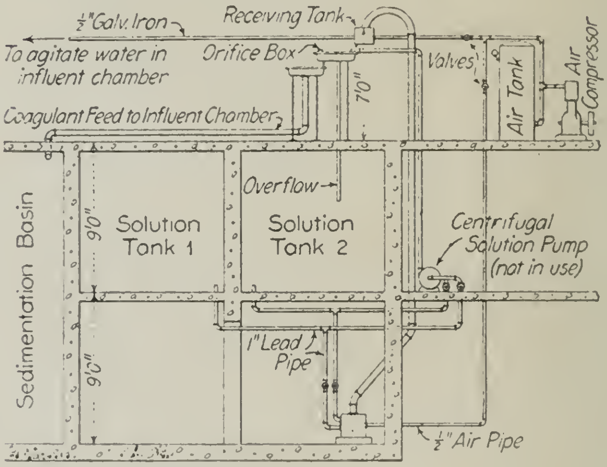
Finally, a man came along that stuck to the job. As soon as he was settled he turned his attention to the ammonia rods. The oil-cup connections to the stuffing-boxes struck him as peculiar and not according to the best practice, so he decided to change them.

The sketch shows the oil cup in the changed position and also shows its original location. The machines were of the horizontal double-acting type. In this machine there is usually more or less gas escaping through the connection to the suction line. With the original connection the escaping gas carried much of the oil along with it into the suction line and into the system; in fact, the system was loaded with oil, as was found later. Connecting the oil cups to the under side of the stuffing-box overcame this defect and thereafter a small amount of oil was needed.—Thomas G. Thurston, in *Power.*

AN AIR LIFT ELIMINATES CORROSION

By utilizing the airlift principle to pump coagulant solution in the filtration plant at Ottumwa, Iowa, H. A. Brown, superintendent, has eliminated pump corrosion difficulties. Originally the plant was equipped with small centrifugal pumps made of "acid-proof" bronze. They were serviceable only a little more than two years, being so badly eaten away by that time as to render them useless.

To solve the annoying problem the superintendent conceived the idea of using an air-lift and installed an experimental pump consisting of a 1¼-in. pipe placed in the solution tank and discharging into a receiving tank over the orifice box. The bottom end of the 1¼-in. pipe was split for about 6 in. to receive the upturned end of a ½-in. air pipe. This crude form of an air-lift worked satisfactorily until the solution in the tank was one-third used up. Due to an insufficient submergence, the remainder of the liquid could not be discharged.



AIR LIFT IN FILTERATION PLANT.

A permanent installation was made by connecting a 12 x 12 x 8-in. lead box, located 9 ft. below the bottom of the solution tanks, with a 1¼-in. lead pipe discharging into the receiving tank. A ½-in. lead air pipe was brought into the side of the box and directed into the 1¼-in. pipe. The solution tank is 9 ft. deep and the receiving tank is 7 ft. above the solution tank thus giving a submergence of from 36 to 72 per cent. of the total lift. Under this condition the pump works successfully and the full capacity of the solution tank can be utilized. Air under 5 lb. pressure is employed.

Decorated glass is made by painting the surface with easily fusible glazes. After drying the glass is put in a kiln and heated sufficiently to fuse the glaze.

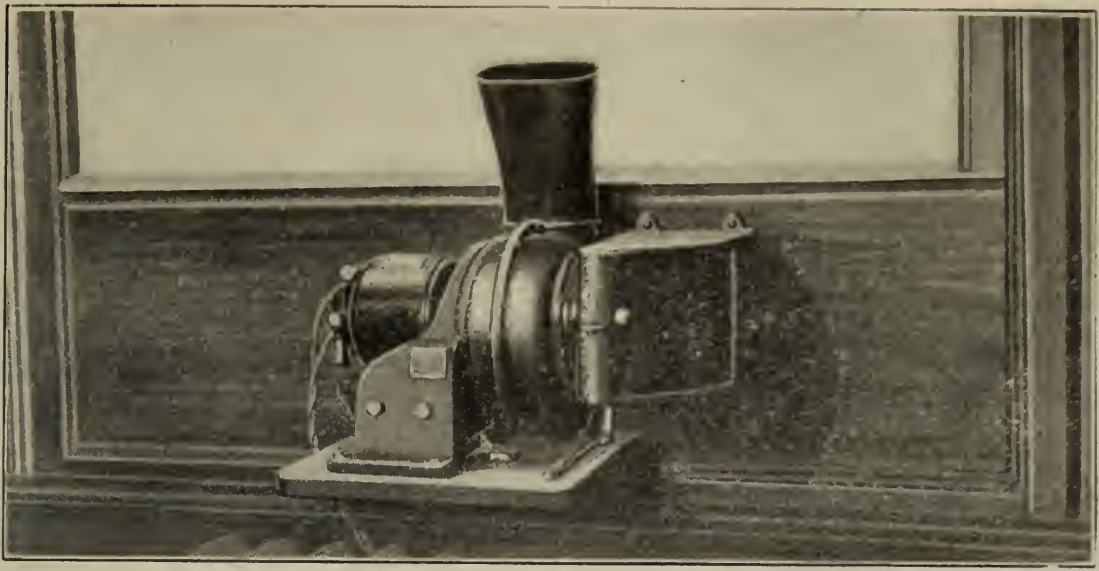


FIG. 1.

FRESH AIR VENTILATION WITHOUT DRAFTS

The Chicago Ventilation Commission some years ago came to the conclusion that ventilation with cold outdoor air was impractical, owing to the tendency of very cold air to resist diffusion with the warmer air of the room. The air warmed by the radiators went to the ceiling while the cold air fell to the floor. The Gerdes ventilator, manufactured by Gerdes & Company, 30 Church street, New York, overcomes this difficulty in two ways: by blowing the cold air to the ceiling with sufficient velocity to cause it to creep along the ceiling until it fals away in all parts of the room, and, when the weather is very cold out of doors (below 25 degrees F), by mechanically mixing enough warm air from the room with the cold air to bring the temperature of the mixture to a normal coolness (about 30 degrees F). The result is that a uniform temperature exists from floor to ceiling .and absolutely no draughts are felt, in fact, it is impossible to feel that cold air is coming into the room.

The ventilator consists of a Westinghouse Sirocco blower together with a combined duct and mixing chamber for bringing outdoor air or indoor air to the blower, or a mixture of the two sufficient to maintain a comfortable atmosphere in the room. When the slide in the duct is brought forward and the duct closed to the room, as shown in Fig. 1, the blower draws only cold outdoor air, when it is pushed back the cold air is cut off and air from the room is recirculated; when the duct is partly open to the room, as shown in Fig. 2, the slide closes the opening to outdoors by the same amount and streams of cold outdoor air and warm indoor air mix in the blower. By adjusting the slide any temperature can be had at the nozzle between that existing indoors and out. The cool mixture, being blown to the ceiling, spreads out against it, and, after losing its momentum, gradually sinks through the warm room air and is breathed before it passes to the radiators.

The outfit is operated by current from the lighting circuit. It requires about the same current as an ordinary incandescent bulb and

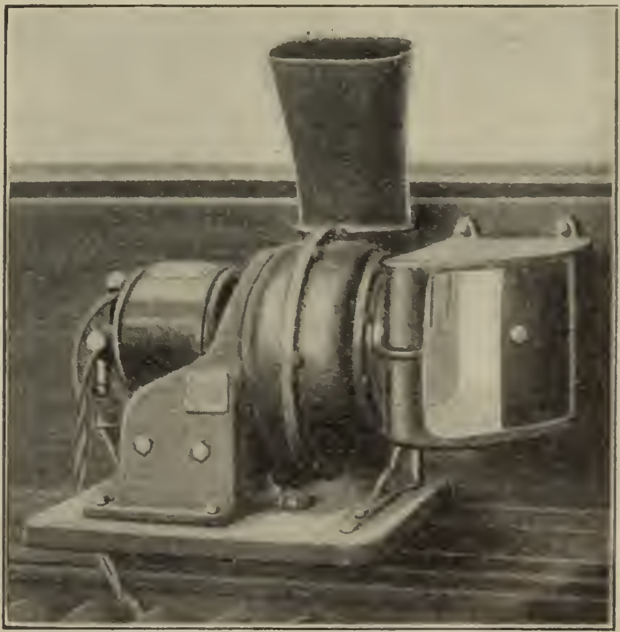
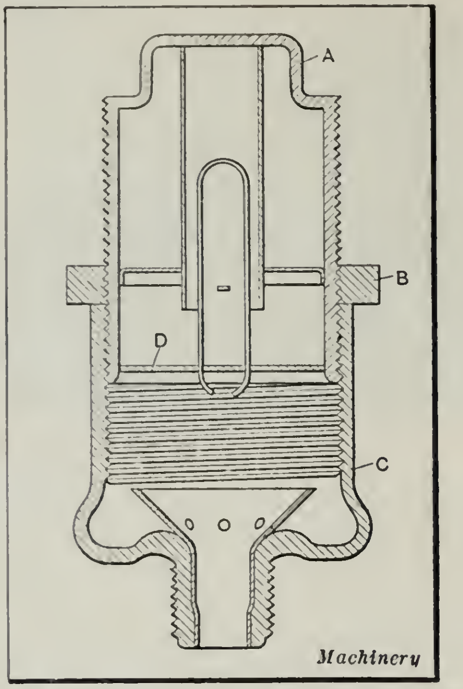


FIG. 2.

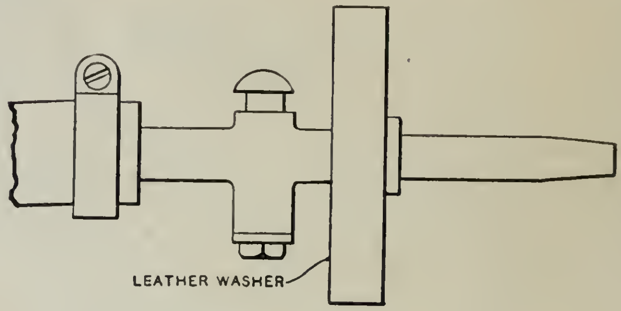
no special wiring is necessary. It can be installed or removed in a few minutes and the placing of the window board in the window frame causes no damage to the woodwork.



A COMPRESSED AIR GREASE CUP

The cut here reproduced from *Machinery* shows the essential features of a new grease cup described in *Engineering*, London. It is entirely self contained and is not dependent for its operation upon an air compressor or any outside supply of compressed air, the air pressure being secured by the screwing down of the inverted cup which forms the cap.

The lubricator, as will be seen from the illustration, consists of three main parts: a cup *C*, a cover or top *A*, and a lock-nut *B*. Parts *A* and *C* are pressed out of mild steel or brass. The top *A* contains a suspended disk *D*, the object of which is to keep the upper surface of the grease flat, and prevent the air from forcing a passage through the grease. When the cup is filled with grease, this should be packed down so as to prevent large air cavities in it. The suspended disk is pulled out to the end of top *A*, and the latter is screwed into the cup about ¼ or ⅜ inch, this being sufficient to compress the air the required amount, as all parts are hermetically sealed by the grease. The lock-nut is then tightened by hand. The small funnel at the bottom of the cup is made of thin sheet steel so that if the bearing becomes heated, the heat is quickly transferred to the grease, which melts and runs down. The heating of the grease also heats the confined air and increases its pressure when the pressure is needed. The cup *A* must be screwed down occasionally as the supply of grease decreases.



SAFETY COLLAR TO PROTECT AIR VALVES

In a manufacturing plant making extensive use of compressed air self-closing valves with which all hose ends were equipped frequently gave trouble due to leakage and breakage. A study of the conditions under which the valves were used revealed the fact that when the workers were through using the air they would drop the hose onto the floor near their work so that it would be convenient when needed. As the floors are of cement the valve received a hard blow many times a day. It seemed to be impossible to break the men of this habit of rough handling, partly because the noise of the machinery made it impossible for them to realize what a severe blow the valve really received, and also because the piece work system does not encourage workers to expend any thought on matters that do not immediately increase the "upholstering" of their pay envelopes. The whole trouble was eliminated by the addition of a safety collar as shown. This collar is simply a leather washer about three inches in diameter, built up to a thickness of half an inch and provided with a hole of the proper size to permit it to be slipped onto the nozzle of the valve just in front of the push button. This collar is held securely in place by the addition of a metal band soldered to the nozzle, and the arrangement leaves the valve easy of manipulation and does not prevent getting the air just where it is needed.—*Machinery*.

Analysis of subway dust in New York gave the following contents: metallic iron, 46%; iron oxide, 14.5%; lime and plaster, 12.1%; grease, 1.12%; and water and organic matter, 12.6%.

CHOOSING ROCK DRILL EQUIPMENT

BY P. B. MC DONALD.

Most mines possess rock-drills of several different makes, and some have a motley collection of drills perhaps none too well suited for the work in hand, usually purchased at various times without due regard for any standardization. Thus it is necessary to keep on hand repair-parts, from a half-dozen different drill manufacturers, that have a habit of getting mixed together on the warehouse shelves. A single mine may be driving with Sullivan and Ingersoll-Rand reciprocating drills, stoping with Cleveland, McKiernan-Terry, and Murphy hammer-drills, and sinking with some other make of plugger-drill; while there may be another variety or two of drill lying around the place, either going to rust underground or reposing in idleness in the corner of the warehouse, not used because some one cannot find a certain repair-part, or because a foreman has a prejudice against the type.

There is an excuse, of course, for getting the matter of rock-drills somewhat mixed, becaſse there have been so many innovations in the design and construction of such machines in the past year or two that fashions in drills have changed almost as rapidly as in clothes. Newer and more efficient types of drills have constantly succeeded each other. The general tendency has been toward utilizing the hammer principle; first for up holes, as in overhead stoping; and then for down-holes, as in shaft-sinking by pluggers; and even for more or less flat holes in driving, as with the Leyner or new Sullivan mounted hammer-drill. Lighter, faster, and more automatic drills have also been sought. The heavy columns and bars for mounting drills have been replaced by lighter ones, which do not break a man's back to set up, or by none at all, as in the case of the stopers and sinkers. The future may see driving regularly accomplished by drills hung on a short rope or even held in the hands!

In picking out rock-drill equipment for a new mine, it is well to consider carefully a number of the newest models, and then to standardize on a type or types suitable for three essentials of mining: sinking, driving, and stoping. It is, of course, necessary to know what kind of rock is to be broken. A mounted hammer-drill, such as the Leyner or new Sullivan, may be the best for a hard brittle rock, where clogging by mud in the bottom of the hole is not likely, and where the water principle through hollow steel is useful for dust prevention. For soft sticky rock such as slate, an old-fashioned reciprocating slugger type for pounding out results may give the best satisfaction in the end; in extreme cases even the declining tappet-valve drills may make up in sureness what they lack in speed. However, one or two of the newer light mounted drills can handle a wide range of rock; such as the butterfly-valve one-man machine that so startled operators a year or two ago. An auxiliary-valve drill is also capable of wide use, since such a valve assures both quickness and certainty by its combination of the spool principle with the auxiliary tappet or ball.

The foregoing refers only to mounted rock-drills, such as were used for all purposes around a mine until recently. Today mounted drills have their greatest field in driving, since stopers have superseded them for rising and overhand stoping, and pluggers for sinking. But they are yet an all-around drill, and in a small mine can be used to advantage for any purpose. On the other hand, I have seen several small mines that did all their work with a jack-hammer or two, making it do for all varieties of holes; while a stoper or ordinary hammer-drill can be utilized to do surprising things, as shown in the enlargement of the Rolling-mill shaft at Negaunee, working from the surface down by angle-holes from below. This is also illustrated by the many shifts to which a hammer-drill is turned in small mines, where it has been used for flat holes and driving. Stoping in some mining districts is still carried on with mounted piston-drills on tripods or bars, especially where the ore seam is at a flat angle, as at Birmingham, or where underhand stoping is performed in long 'rooms.' On the whole, however, no one doubts that hammer-drills have revolutionized stoping, as to a smaller extent plugger-drills of the jack-hammer type have revolutionized shaft-sinking.

An additional factor to consider in choosing rock drill equipment is the type of labor that is available to operate and repair the drills. In some districts, it is impossible to get intelligent men, so that a drill requiring brains and judgment to make it go cannot be employed even though it is a whirlwind at drilling when it operates. For a large mine with capable machinists and well equipped shops, specialized and freak drills can be tried, and often marvelous results attained, but for a small mine with none too good labor, a drill should be selected which will stand abuse and poor care, and will run fairly well anyway.

Some drills are finicky. They will drill very fast for a time, and then need nursing and humoring. The Leyner drill was formerly accused of this fault, but since the Ingersoll-Rand Company has been manufacturing it, several improvements have been made that lessen the tendency. And it cannot be denied that in hard rock, with intelligent operators, the water Leyner is, like the old race-horse Maud S., a world-beater. Very likely other mounted hammer-drills will be put in the field, since the Leyner has demonstrated what can be done in that line, utilizing the scientific advantages of the hammer principle over the slugging or reciprocating method of punching hard rock. In fact, the new Sullivan mounted drill is much like the Leyner, being a 145-lb. machine of the hammer type with water attachment.

There are several other points of some importance to be observed in choosing a rock-drill, such as methods of lubrication, short-stroking arrangements, length of feed, and so on. But such details can best be decided by the man on the job to suit his own ideas on the subject, and no general principles are involved beyond common sense.

As to the various hammer or stoper drills of the unmounted air-feed type, I do not think there is so much difference. There are a number of good ones on the market. Their valves differ, some have spools, some butterfly, some ball valves, and some no valve at all, but practically all of them will hold a drill-steel fairly close to the face and hammer it "fast and furious."

As with stopers, so with pluggers or sinkers, there are a number of good makes on the market, and it is not so necessary to exercise careful judgment in the selection. It is not meant to imply that some stopers and pluggers have not certain advantages over others of their class, but such advantages (aside from automatic rotation of pluggers) are usually merely mechanical details which appeal to one superintendent and not to another. Thus it is a question of personal conviction; more than a matter of principle, whether a stoper has ordinary or reverse feed, whether it weighs 55 or 100 lbs., whether a plugger rotates by the reciprocating energy of the hammer or by a separate small engine. Such matters can be best decided by the superintendent on the job to suit his own ideas and the details of the situation. It need only be said that the automatically rotating plugger is a surprisingly satisfactory drill for shaft-sinking or down-holes in general. Hollow drill-steel is generally used for blowing out the rock-chippings by air or water. Other things being equal, having selected a stoper or plugger-drill, it is good practice to standardize the type for its own class of work in order to simplify the repair-parts problem. A large mine will probably require three kinds of rock-drills; mounted drills (either reciprocating or hammer type) of one-man or two-man style, for driving and all-around work (including perhaps stoping); stoper hammer air-feed drills for rising and overhead stoping; pluggers for shaft-sinking and block-holing.—*Mining Press.*

GETTING A LIVING BY SUCTION

A certain fish which is generally known as the remora, or shark-sucker, has modified the gills on the back of his head so that they form a sucker. With this he "hitches on" to the underside of some big predatory fish, generally one of the sharks, and thus, without having to use his own fins and tail at all, he is pulled through the sea, getting a free ride. Whenever the shark finds a school of fish he dashes among them at great speed, snapping his huge jaws in every direction and killing twice as many fish as he can eat. The remora then unhitches himself and dines quietly off the fragments of half-eaten fish that come slowly sinking down through the water. It takes less to fill him up than it does the shark, so his hunger is usually the first to be satisfied. When he has dined, lunched or breakfasted, as the case may be, the remora swims below the shark again, and after his free meal gets ready for more free transportation.

The rivers of the United States carry yearly to tidewater 270,000,000 tons of dissolved matter and 513,000,000 tons of suspended matter. This total of 783,000,000 tons represents 350,000,000 cu. yd. of rock, or 610,000,000 of surface soil.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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FIRST AWARDS OF THE FRANKLIN MEDAL

The Franklin Medal, the highest recognition in the gift of the Franklin Institute of the State of Pennsylvania, has recently been awarded to Heike Kamerlingh Onnes and to Thomas Alva Edison

The fund from which this medal is awarded was founded Jan. 1, 1914, by Samuel Insull. Awards of the medal are to be made annually to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the Institute, have done most to advance the knowledge of physical science or its applications, the present awards being the first that have been made.

The medal awarded to Prof. Onnes was received on his behalf by His Excellency, Chevalier van Rappard, Minister from the Royal Netherlands Government, at the stated meeting of the Institute on the evening of May 19, and at this meeting Mr. Edison was the guest of the Institute and received his award in person. Following the presentations an address entitled "Electricity and Modern Industrial Growth" was delivered by Mr Insull.

Sketches of the lives of the recipients of the medal, and also of Mr. Insull, the donor are appended:

THOMAS ALVA EDISON.

Thomas Alva Edison was born at Milan, Ohio, February 11, 1847. In 1854 he went with his parents to Port Huron, Mich. His early education was received from his mother.

Very soon his fondness for chemistry became apparent, and at the age of twelve, to obtain money for the purchase of chemical apparatus, he became a train boy on the Grand Trunk Railway, operating between Port Huron and Detroit. While working in this capacity he secured a hand press and edited and printed a small paper, *The Weekly Herald*, selling some three hundred copies per week to employees of the road. Train telegraphy was taught him in 1862 by the station agent at Mt. Clemens, Mich., where he later became the operator. The following year he was transferred to Stratford Junction, Canada, but his dislike for routine work led him to become a tramp operator, and for the next five years he moved from one to another station in the middle West.

In 1864, while in Indianapolis, he invented an automatic telegraph repeater. This was probably the first of his long series of inventions.

In 1868 he moved to Boston, where he obtained a position with the Western Union Telegraph Company. While here he invented a vote-recording machine, for which he obtained his first patent, in 1869. There was no demand, however, for such a machine at the time, and it was not developed to a commercial success.

Soon after this he invented a stock ticker, and started a ticker service in Boston, with about forty subscribers. At this time he also experimented with a duplex telegraph, but this not being at first successful he devoted himself to the commercial development of his stock ticker, which was later sold to New York capitalists for $40,000. His work in this connection brought him into association with the late Franklin L, Pope, with whom he entered into partnership in 1869. J. N. Ashley later also became a partner, and the firm secured a large amount of business. With the money Edison received for his improved ticker he established a factory at Newark, N. J. for building these machines in large quantities.

Experimenting again with the automatic telegraph he developed it to a point where he was able to send three thousand words per minute between New York and Philadelphia and record them in Roman type. An arrangement was then made with the British postal telegraph authorities to demonstrate the automatic system in England, and Edison went over in 1873 to make the demonstration.

In 1873 Bell invented the telephone, but something more powerful than the magneto transmitter, or something capable of amplifying without distortion extremely small telephonic currents, was necessary, among other things, for its commercial success. In 1875 Edison devised his carbon transmitter, now almost universally used.

In 1878 he invented his tinfoil phonograph, creating world-wide interest, and a number were constructed for exhibition purposes. This machine was succeeded by his wax-cylinder machine, in 1888, which later developed into a device of great commercial value.

His contributions to the art of electric lighting have been fundamental. In 1876 he moved to Menlo Park, N. J., where for ten years he was engaged on his incandescent lamp, dynamo, and system of low-pressure electrical distribution. The Pearl Street Station in New York City, started on September 4, 1882, the first successful electric station in America, will ever remain a monument to Mr. Edison's skill and tireless energy. By the end of December of the same year this station was supplying current to over five thousand incandescent lamps.

Electrical problems easily solved to-day were by no means easy of solution thirty-odd years ago, and it is doubtful if more than a very few electrical engineers of the present generation are conscious of the debt they owe to the great electrical pioneers of the '70's and '80's.

Motion-picture apparatus and alkaline storage batteries are among many other inventions produced by Mr. Edison as a result of incessant effort and great concentration.

That he has lost none of his youthful energy or determination in the matter of overcoming difficulties is seen by the rapidity with which he reconstructed his enormous factories at Orange, N. J., destroyed only on December 9, 1914, by fire.

HEIKE KAMERLINGH ONNES.

Heike Kamerlingh Onnes was born on September 21, 1853, at Groningen, Holland, where his father was engaged in manufacture. He was educated in the schools of his native town, and there also he began his university studies in 1870. Two years later he removed to Heidelberg, where he spent three semesters, working under the direction of Bunsen and Kirchoff. He then returned to Groningen, and a few years after he became assistant to Professor Bosscha at Delft, where he commenced work upon his thesis for doctorate. In 1882 he and H. A. Lorentz were appointed professors of physics in the University of Leiden, then a little known and quite unpretentious seat of learning (so far as physical science was concerned), but which, as a result of the collaboration of these two highly-gifted and energetic young physicists, has become one of the world's great centres of physical research.

While Lorentz confined his energies mostly to the fields of theoretical and mathematical physics, Onnes directed his energies to the creation of a laboratory for experimental research. In spite of great obstacles, particularly of very inadequate appropriations for equipment and maintenance, the indefatigable director found ways and means of furnishing his laboratory with the special machinery and precision instruments required for the researches of the professors and their students. A very important—in fact, an essential—factor in this development was the establishment by Onnes of a training school for mechanicians, and it was in the shops of this school that many of the special instruments for the laboratory were constructed. At the same time the young men engaged there were trained to assist the director in carrying out the often difficult and intricate operations in his experimental work. On various occasions Professor Onnes was thus enabled to command a force of some thirty assistants, to each of whom a special duty was assigned.

The work of this great laboratory at Leyden is recorded in the *Leiden Communications*, published since 1891, and includes a vast number of most important contributions to physical science. Among them are investigations on magneto-electric effects, as well as a series of most important papers upon magneto-optical phenomena, such as the classical one by Zeeman, describing the discovery of what is now known as the Zeeman-effect. But, while these early investigations were all carried out under Onnes' direction, they were in many cases inspired or suggested by his distinguished colleague, H. A. Lorentz.

The really representative work of the laboratory has been in the field of molecular physics, and particularly in research at low temperature. The great bulk of the *Leiden Communications* is devoted to the records of those remarkable series of researches which were conceived by Onnes himself and carried out under his direction. The history of these researches began with the creation of the cryogenic laboratory, and it may be divided into several distinct stages or periods. The first of these was occupied with the production of liquid oxygen on a large scale, and with the use of this material in a three-cycle process of obtaining low temperatures, by which Onnes was enabled to maintain and control the temperature ranges from —23° to —90° (methyl chloride), from —105° to —165° (ethylene), and —183° to —217° (oxygen). This goal may be said to have been attained about 1894. The second stage was characterized by the introduction of liquid hydrogen and the production of temperatures below —217°. The abnormal behavior of hydrogen gas when it is allowed to expand under reduced pressures made it impossible to liquefy it at higher temperatures; and the condensation of this gas was first achieved by Dewar, of London, on May 10, 1898. This added a new range of available low temperatures from —253° to —259° in which Dewar made a number of highly remarkable observations, including the solidifications of hydrogen. But Onnes very promptly appropriated this new range for his research work, and constructed novel and very efficient apparatus for the production and utilization of the new refrigerant.

The Netherlands Government, realizing the importance of the work, now granted considerable appropriations for the extension and equipment of the laboratory, and with its completion a new era of constantly increasing low temperature research began. New methods and instruments for the exact measurement of temperatures below the boiling-point of liquid hydrogen were devised, and the behavior of mixtures of hydrogen and helium was systematically investigated. Finally, the apparently incoercible gas, helium, was reduced to the liquid state. This crowning triumph of low temperature research was achieved on July 10, 1908. While this supreme achievement aroused universal interest in the work of Onnes and doubtless prompted the award to him, in 1913, of the Nobel Prize in Physics, it was by no means (as many seem to suppose) a *tour de force*, but only the culmination of the long-continued and unremitting life-work of a great investigator.

During the past few years Onnes has made some most remarkable discoveries with reference to the electrical resistance of certain metals at temperatures only a few degrees above the absolute zero of temperature. The resistance of metals ordinarily varies approximately with the absolute temperature, but at temperatures only a few degrees above the absolute zero it suddenly becomes so small that it can hardly be measured. For mercury this "critical temperature" is 4.2° absolute; for lead it is 6.1°; and for tin 3.8°. Below these temperatures the resistance is practically *nil*, and Onnes terms this the "supraconductive" state. In this state the metals no longer obey Ohm's Law—there is neither a potential drop nor a production of heat. Onnes has shown that, in a lead coil cooled to 1.7° absolute, a current of 0.4 ampères induced in the coil by the removal of an electromagnet whose flux had previously passed through it continued to flow without appreciable diminution for more than two hours. This result is bound to exert a profound influence upon our views of electrical conduction and molecular magnets, and perhaps the use of supraconductors may some time afford much stronger magnetic fields than are now available.

SAMUEL INSULL.

Samuel Insull was born at London, England, in 1859, and was educated in private schools in that city, at Reading and Oxford. He came to the United States in 1881 and became private secretary to Thomas A. Edison, of whose business affairs he had full charge for many years. He represented Edison in the organization and management of the Edison Machine Company, the Edison Lamp Company, and others of his early corporations. In 1889, upon the consolidation of the various Edison concerns into the Edison General Electric Company, he was appointed second vice-president of the corporation and assumed charge of its manufacturing and selling departments. Three years later the General Electric Company was formed by consolidating with the Thomson-Houston Company, and he continued in the same capacity with the new concern. He resigned a few months later to organize and become president of the Commonwealth Electric Company ot Chicago. Since 1907 he has been president of the consolidation of this company with the Chicago Edison Company—The Commonwealth Edison Company, which controls the electric lighting service of the City of Chicago —and he is also an executive of a number of other public service companies. Mr. Insull is a member of the American Institute of Electrical Engineers and the British Institution of Electrical Engineers.

The extraction of gasoline from casing-head gas (natural gas from oil wells) has become one of the important adjuncts of the natural-gas industry in the United States. The production is increasing rapidly, the quantity produced in 1913 having almost doubled that of 1912. It is principally used for raising the standard of naphthas or low-grade distillates consumed in motors; it is also used for lighting; and it can be used like regular gasoline in all the arts.

NEW BOOKS

Centrifugal Pumps. By R. L. Dougherty, Assistant Professor of Hydraulics, Sibley College, Cornell University. McGraw-Hill Book Company, New York, 1915. Cloth, 6 by 9 in. 202 pages, 111 illustrations. $2.00 net.

The rapidly increasing use of centrifugal pumps, thanks largely to the direct electric drive, gives this book a special timeliness. The writer is familiar with his subject and has done his work thoroughly. The various types of pumps are described and illustrated, the theory of operation is lucidly investigated and the practical employment of the pump under various conditions is gone into thoroughly, giving costs, power required, efficiencies, etc. The different chapters are supplemented by problems the solution of which should guarantee a thorough understanding of the subject.

USE OF EXPLOSIVES IN METAL MINES AND QUARRIES

The United States Bureau of Mines, several years ago, issued a primer on explosives for coal miners which has been in considerable demand ever since. Now the bureau has issued a primer on explosives for metal miners and quarrymen, by Charles E. Munroe and Clarence Hall. The bulletin, which has just come from the printing office, says in its instroduction: "In accidents resulting from the use of explosives in metal mines and quarries in the United States more than 130 men were killed and 250 seriously injured during the calendar year 1913. Moreover, an unknown number of miners suffered from the effects of breathing the harmful fumes and gases given off by the burning or the incomplete explosion of some explosive. Consequently, the Federal Bureau of Mines, which is endeavoring to increase safety in mines and to abolish conditions that tend to impair the health of miners, is studying the kinds of explosives used in mining and the conditions under which these explosives can be used with least danger to the miner.

"Inflammable gas or dust is seldom, if ever, found in quarries or metal mines, and the danger from using explosives there is less than in coal mines; but, as the figures show, the number of men killed and injured yearly in accidents caused by explosives proves the need of both miners and mine officials striving to see that none but proper explosives are used and that these are used properly."

The bulletin contains chapters on combustion and explosion; blasting and mine explosives; fuse, detonators, and electric detonators; firing blasts by electricity; the use of explosives in excavation work; the use of explosives in quarrying; the use of explosives in metal mining and tunneling; drilling and blasting methods on New York rapid-transit tunnel; magazines and thaw houses; permissible explosives, etc.

This publication is Bulletin 80, and it may be obtained free of charge by those interested writing to the Director of the Bureau of Mines, Washington, D. C.

HONORS TO THE INVENTORS OF THE HUMPHREY PUMP AND THE ESCALATOR

The City of Philadelphia, acting on the recommendation of The Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Herbert Alfred Humphrey, of London, England, and to Cav. Ing. Alberto Cerasoli, of Rome, Italy, for the Humphrey Pump, a device for raising water by the direct application of the explosive energy of a mixture of combustible gas and air. The first installation of a Humphrey Pump was made at Dudley Port, in England, in 1909. Three years later, four pumps, each having a capacity of 40,000,000 gallons per day, and one pump of 20,000,000 gallons per day, were installed by the London Metropolitan Water Board. Tests subsequently made on these pumps gave an average fuel consumption of 0.904 pound anthracite coal per pump horse power hour.

The Edward Longstreth Medal of Merit has been awarded to the late Mr. George A. Wheeler for his Escalator. This invention is an inclined elevator for transporting persons from one level to another. It consists of an endless system of stairs or steps having risers and treads, together with top and bottom landings.

ANNUAL MEETING OF ADVERTISING CLUBS

Chicago will be the scene of the eleventh annual convention of the Associated Advertising Clubs of the World which meets June 20 to 24. This great gathering of the dynamos of the business world to discuss common problems and to advance the banner of truth in advertising promises to hold a unique place in the events of the year. On the Sunday preceding the formal opening of the convention, fifty business men of country wide reputation will deliver lay sermons in Chicago churches.

New features include a conference of the teachers of advertising and another of the secretaries of advertising clubs. Departmental meetings of men in the several fields of work give opportunity for a discussion of the problems of various phases of advertising, an arrangement which reflects the new freedom in business.

Amusements include a list of social functions for the ladies, a Gridiron Show to be staged by one hundred and fifty Chicago men, lake and automobile trips. A whirlwind campaign is being waged by advertising clubs in an effort to mobilize in Chicago at full war strength.

NOTES

It is expected that the new steel plant of the International High Speed Steel Company at Rockaway, N. J., will be in full operation at the end of the present month. The product will be confined to the company's highest grades of tool steels, alloy steels and high speed steels of all shapes and sizes, rock drill steels, solid octagon and cruciform, hollow hexagon and round, not heretofore made in the United States.

Repair cost of storage-battery locomotives at the Bunker Hill & Sullivan mines runs from $0.00359 to $0.01189 per ton hauled. Trolley locomotives cost from $0.00435 to $0.00641 per ton. In the first instance the highest expense was up to $55.456 per month, and with the other machines $93.912 per month.

The number of deaths of aviators in the war service is very much smaller than the death records in time of peace, one of the explanations being that aerial navigation is quite safe when there is no indulgence in exhibition stunts that have brought so many disasters. When an aeroplane is handled by a skillful aviator for the legitimate purpose of plain flying, it is a very much safer means of transportation than is generally believed.

The gas company at Nashville recently demolished an old holder which was 110 ft. in diameter by means of the oxy-acetylene torch. They made 26 vertical cuts around the circumference and as each slice was cut off it was hoisted out of the tank. The metal was 3-16 inch thick with ¾-inch angles and ½-inch thick channels. This work was done by one man in a week, showing the wonderful effectiveness of this little apparatus for big work. In fact the use of this torch for wrecking metal structures has extended itself as a regular equipmnt for some fire departments, where its use has been found of value in saving life and property.

A 26-part tackle with 7,000-ft. hoist lines forms the main fall rigging of the erection traveler used on the Hell Gate arch bridge. A few pieces of 175 tons erection weight and a number weighing over 100 tons have to be handled, those of the east half being already placed. The tackle consists of two 13-sheave blocks. The great length of line is needed to enable the traveler to hoist direct from the river. The boom-fall rigging has 36 parts of wire rope rigged tandem, and is really two separate tackles side by side and connected to an equalizer. Each top block has six main sheaves and four smaller ones. Each bottom block has five main sheaves and five smaller ones. The two ends of each tackle lead to drums, so that there are four lead-lines, going to two drums each with a partition in the middle.

The importance which gas is assuming in the world's activities was again exemplified when the German artillery projected bombs into the camps and trenches of the Allies, these bombs on exploding liberating asphyxiating gases which spread a choking blanket two miles wide over the enemy and caused them to "get out of there" pretty quickly. As a means of carrying on war it is bloodless but none the less effective. Some day we will be fighting fires with such gases in the regular equipment, mobs will be dispelled by pungent or non-breathable gases, we will have gas-pistols as well as gas bombs and something will be found to put into city gas to make suicide by its means a very unpleasant process. We are progressing.—*Gas Age.*

Zinc instead of mortar was used for joining the stones of two elliptical arches of 82 ft. span that support a newly completed reinforced concrete bridge near Lyons, France. Previous experiments having proved that the molten zinc—at 800 deg.—caused no fractures in dry stones, the zinc was melted and poured between the stones, forming metallic joints ⅛ in. thick. This substitution for mortar increased the cost about $2.40 for each sq. ft. of the bridge's horizontal surface. Tests with cubical stones, 2½ in. on a side, showed that zinc joints do not weaken stones having a strength of about 14,000 pounds per sq. in., but are weaker than stones having a strength between 14,000 and 18,500 pounds. A less compressible metal is needed for very hard stones. Cement joints, when as thick as 1-25 in., or less, stood the tests equally well, but disintegration gradually reduces the original strength of joints of mortar.

Du Pont Magazine states that one ingenious contractor placed "the dynamite to be thawed on shelves around the sides of a small building about 10 ft. square with double walls, in the middle of which was an oil stove. A thermometer was placed at a convenient point in the room and a man was instructed to stay in the thaw-house continually while the oil stove was burning to watch the thermometer and turn down the wick when the temperature rose above 80° F. To insure the faithful performances of his duties he was *locked in the room* by the foreman of the blasting gang, and had, therefore, every incentive to keep the temperature at a safe point, as he had no opportunity to evade his responsibility."

Some idea of the wealth of published material relating to oxyacetylene welding may be obtained from a 34-page pamphlet that has been issued by the New York Public Library. This contains a list of works on this subject that may be found in the library, and includes books, articles from periodicals, pamphlets and other literature that is readily accessible. The arrangement is chronological by date of publication from 1893 to October, 1914, and contains a list of 487 books, pamphlets, magazine articles, etc. An index which is arranged by subjects and authors is included. For references to acetylne other than in its relation to welding, readers should consult the various periodicals related to the industry.

The oxy-acetylene welding process has been used successfully for building up flat spots on locomotive driving wheel tires and restoring them to perfect condition. Instead of removing all the drivers of locomotives and turning them down to the common diameter made necessary by the depth of the flat spots, the flats are filled in with metal welded to the tire, and in a few hours the locomotive is ready for the road. The process saves tires, machining expenses and locomotive time.

In a recent lecture before the Royal Institution Professor Boys showed one of the early flat-flame burners giving a light of 1 candle-power for each cubic foot of gas consumed per hour. Then a more modern burner was shown, giving 2 candle-power. Various types of incandescent burners were next shown, and the lecturer mentioned the results of high-pressure incandescent gas lighting in the London streets, whereby 60 candle-power was obtained per cubic foot.

An interesting feature of the production of granite in California is the quantity of stone quarried from large residual bowlders. These bowlders, according to the United States Geological Survey, represent the remains left from prolonged disintegration of large granite masses, but after a thin weathered coating is removed they yield sound stone.

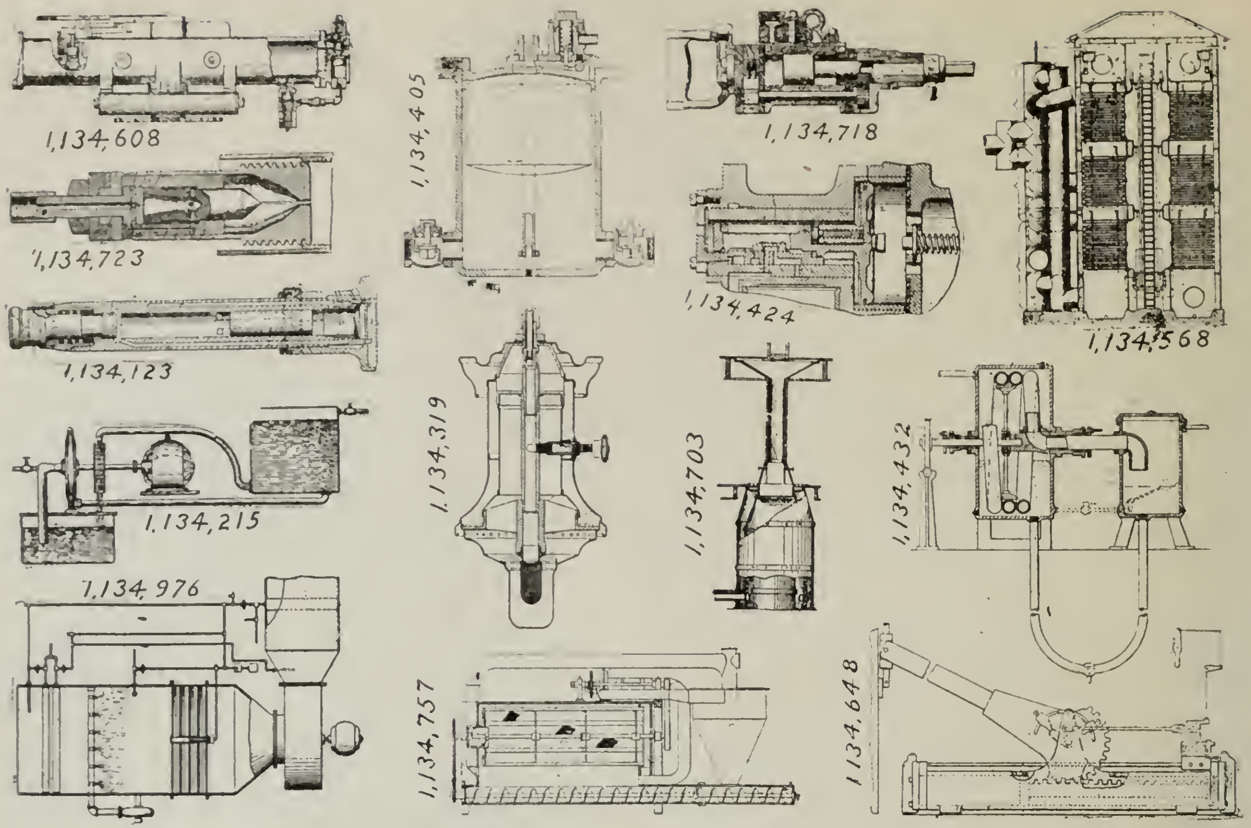
A simple and effective scheme for killing destructive small animals in their burrows has been discovered by Leonardo Ruiz, a rancher, of Ravenna, Calif. About 1½ or 2 in. of a 40 per cent dynamite stick is wrapped in a cloth or paper and provided with a fuse but no detonator. One of these charges is stuck down into each hole and some loose dirt backed around the fuse. There is (or should be) no explosion after lighting the fuse; the dynamite merely burns, filling the hole with dense poisonous fumes. The cost of materials is about 2c per hole.

Every year there averages in the United States between 1300 and 1400 serious boiler accidents, of which 300 to 400 are violent explosions. These accidents kill between 400 and 500 persons, injure 700 to 800 more, and destroy more than half a million dollars' worth of property. In a single explosion, that of the R. B. Grover Shoe Co., at Brockton, Mass., 58 persons were killed, 117 more were injured $250,000 worth of property was destroyed, and an aggregate of $250,000 was claimed in the personal injury and death suits that were brought. In a period of 46 years, since 1867, over 10,000 people have been killed and over 15,000 injured in boiler explosions.

At the plant of the Northwestern Malleable Iron Company, Milwaukee, air for the furnaces was formerly supplied from blowers located at some distance from the furnace which they served, necessitating a considerable length of pipe. For driving these blowers 40 hp. motors were used. Recently individual slow speed blowers have been placed alongside each furnace and 7½ hp. motors, direct connected, have been found of ample size to furnish all the power required.

Fire Commissioner Adamson, of New York, in his report to the mayor says that last year's per capita fire loss was the lowest for any year in the history of the city save one, and the total fire loss the lowest of any year since 1907 save two, although the population is 1,379,000 greater. These results, he says, he has achieved with a budget for 1915 reduced by $65,000 from the budget for 1914, although he has made provision for twenty new fire companies at a cost of $400,000 a year. There has been an increase of 58½ per cent. in the number of orders of the Fire Prevention Bureau which have been obeyed, and an increase of 29½ per cent. in the number issued. He has also established in the courts the right of the fire commissioner to recover the cost of extinguishing a fire which is the result of "culpable and wilful negligence."

The marble columns for the Lincoln Memorial now being erected in Washington are the largest of their kind in the world. Each block weighs about 35 tons as it comes from the quarry, and twelve blocks are required for each 46-ft. column. When completed, one column weighs 192 tons and involves a cost of $15,000. The stone is being shaped at Marble, Colo.: first the blocks are sized with wire saws to the required thickness, then they are passed through the barrel saw, which cuts them into drums. These drums are trued up upon huge lathes, then fluted by carborundum wheels. Finally they are hand finished and each drum fitted perfectly to the one above and below it.



Pneumatic Patents April 6.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 6.

1,134,098. PERFUME - SPRAYER. Mayer Jules Robert Bloch, Paris, France.

1,134,123. FLUID-OPERATED TOOL. Louis W. Greve, Cleveland, Ohio.

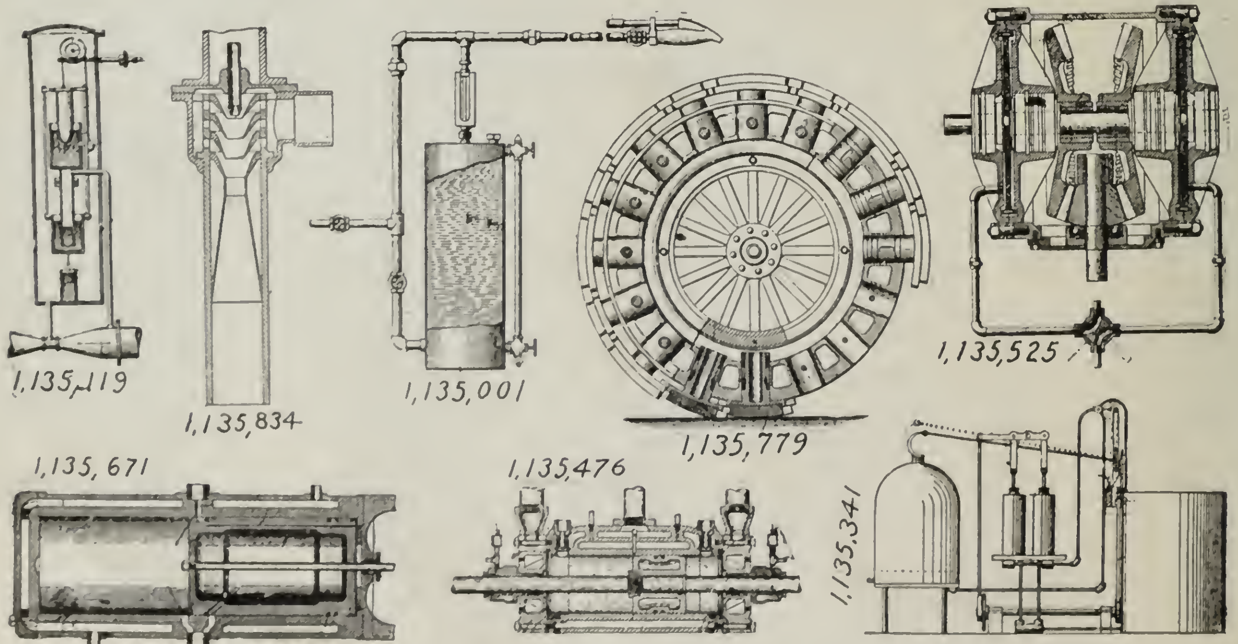
1,134,186. MEANS FOR INFLATING PNEUMATIC TIRES. William J. Drew, Racine, Wis.

1,134,215. AIR PUMPING APPARATUS. Robert V. Morse, Ithaca, N. Y.

1,134,294. VACUUM-CLEANER. Georg Supanz, Vienna, Austria-Hungary.

1,134,319. COMPRESSED-GAS LAMP. Ernst Dresler, Neukolln, Germany.

1,134,402. PNEUMATIC-DESPATCH-TUBE APPARATUS. John T. Needham, New York, N. Y.



Pneumatic Patents April 13.

1,134,405. PRESSURE-PUMP AND VACUUM-TRAP. John Edward Lewis Ogden, Liscard, England.

1,134,424-5. RETARDED RELEASE TRIPLE-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,134,426. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,134,432. PROCESS AND APPARATUS FOR COMPRESSING, DRYING, AND TRANSFERRING CHLORIN GAS. Jonas W. Aylsworth, East Orange, N. J.

1,134,440. ELECTROPNEUMATIC BRAKE. John W. Cloud, London, England.

1,135,119. FLUID-METER. John W. Ledoux, Swarthmore, Pa.

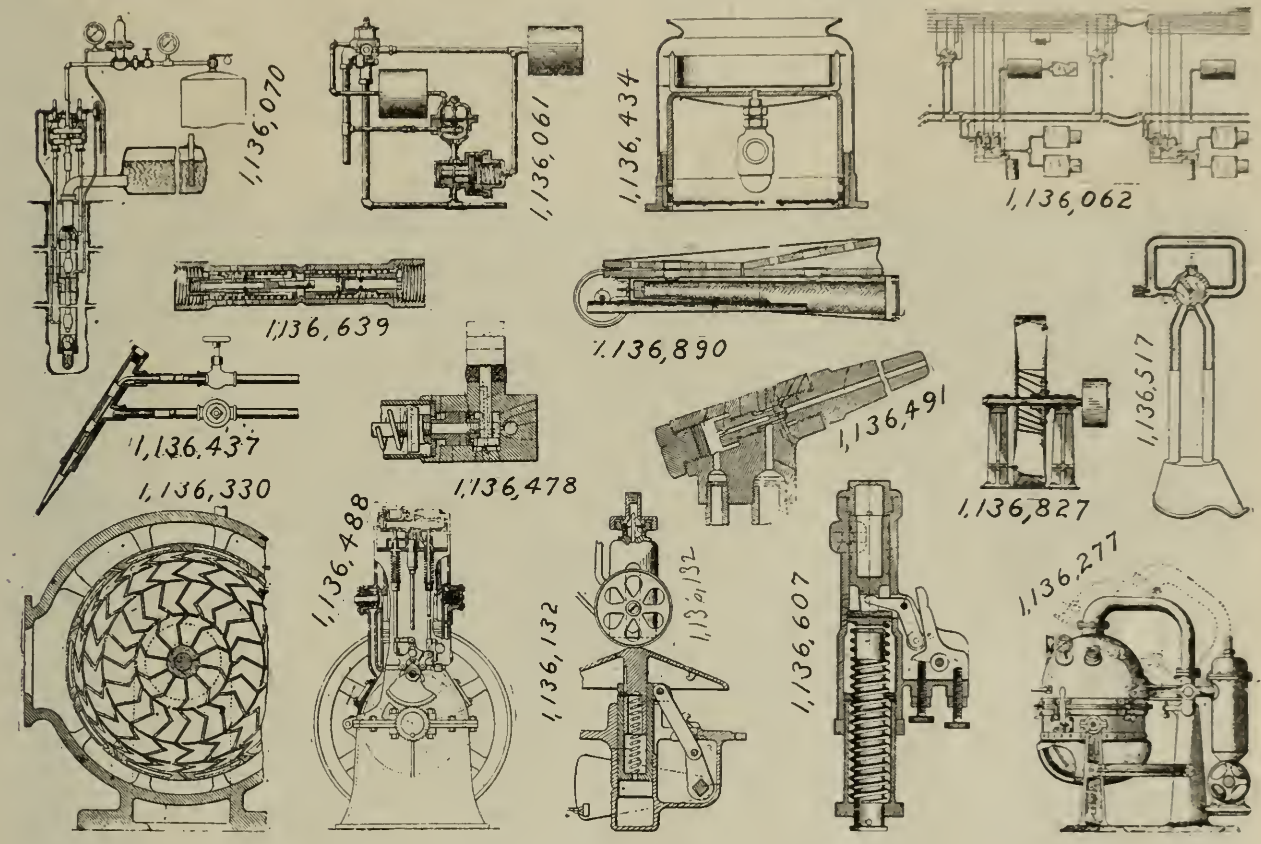
1,135,152. PNEUMATIC AUTOMATIC MUSICAL INSTRUMENT. Robert J. Bennett, Moline, Ill.

1,135,178. FLUID-OPERATED TOOL. Louis W. Greve, Cleveland, Ohio.

1,135,341. TREE-SPRAYER. Jay Wilcox, Rothbury, Mich.

1,135,476. VALVE FOR AIR-COMPRESSORS. Elmer A. Watts, Springfield, Ohio.

1,135,525. FLUID-ACTUATED CLUTCH. Robert L. Hibbard, Sewickley, Pa.



Pneumatic Patents April 20.

1,134,568. DRY-BLAST SYSTEM. Bruce Walter, Pittsburgh, Pa.

1,134,608. FLUID-PRESSURE DOOR-OPERATING DEVICE. Albert Gottschalk, New York, N. Y.

1,134,648. PNEUMATIC OPERATING MECHANISM FOR DOORS, STEPS, OR THE LIKE. George M. Spencer, St. Louis, Mo.

1,134,703. HOT-AIR HEATING SYSTEM. John E. Seltzer, Flint, Mich.

1,134,718. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,134,723. PERCUSSIVE BOILER - TUBE CLEANER. William Burlingham, Newport News, Va.

1,134,757. APPARATUS FOR AERATING FLOUR. William M. Nissley, Philadelphia, Pa.

1,134,853. ELECTROPNEUMATIC BRAKE. Clyde N. Holcombe, New Rochelle, N. Y.;

1,134,976. MEANS FOR HUMIDIFYING AIR. William G. R. Braemer and Samuel C. Bloom, Camden, N. J.

APRIL 13.

1,135,001. APPARATUS FOR CLEANING SURFACES. George Durham and Charles W. McGuirk, Scranton, Pa.

1,135,023. COMPRESSED-AIR AND SUCTION WATER-ELEVATOR. Will L. Jones, Douglas, Ariz.

1,135,610. PNEUMATIC-DESPATCH - TUBE APPARATUS. Albert W. Pearsall and Fred R. Taisey, Lowell, Mass.

1,135,671. FLUID - COMPRESSOR. Elmer E. Davis, West Chicago, Ill.

1,135,779. PNEUMATIC WHEEL. Joseph Dove-Smith, Niagara Falls, N. Y.

1,135,834. HYDRAULIC AIR-EJECTOR FOR VACUUM CLEANING AND OTHER PURPOSES. Campbell Morton, Glasgow, Scotland.

1,135,925. PNEUMATIC CUSHION AND SHOCK-ABSORBER. Fred R. F. Richter, Niverville, N. Y.

APRIL 20.

1,136,061. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,136,062. ELECTROPNEUMATIC BRAKE. Walter V. Turner, Edgewood, Pa.

1,136,070. PUMPING SYSTEM. Frederick C. Weber, New York, N. Y.

1. In a pumping system, the combination of a source of fluid pressure supply, a liquid chamber having inlet and discharge valves, a reversing valve for admitting fluid pressure from said supply to said chamber, and for exhausting said pressure therefrom, and means for throttling the exhaust from said liquid chamber.

1,136,132. AUTOMATIC TRAIN-STOP DEVICE. Albert Edmund Hudson, Calgary, Alberta, Canada.

1,136,190. PNEUMATIC MUSICAL INSTRUMENT. Peder Wiggen, Chicago, Ill.

1,136,227. OZONATOR. Louis Goldberg, Indianapolis, Ind.

1,136,277. COOKING VESSEL. Peter H. Schlueter, Chicago, Ill.

1. In combination, a bowl shaped kettle, a cover adapted to make sealed engagement with the rim of the kettle, said cover being hingedly supported at one side of the kettle, vacuum creating means connected with the cover and means for heating the kettle.

1,136,330. MULTISTAGE CENTRIFUGAL BLOWER. Thomas W. Green, Philadelphia, Pa.

1,136,372. PNEUMATIC ACTION FOR PLAYER-PIANOS. George Schumann, Sr., Union Hill, N. J.

1,136,434. PNEUMATIC CARPET-CLEANER. Edwin E. Overholt, Washington, D. C.

1,136,437. OXYACETYLENE APPARATUS. Michael L. Popp, Milwaukee, Wis.

1,136,470. SPRING AIR-GUN. Charles F. Lefever, Plymouth, Mich.

1,136,478. PRESSURE-TRANSMITTING CONTROLLER. Francis E. Mills and Edward F. Mills, Boston, Mass.

1,136,491. ACETYLENE BLOWPIPE. Elmer H. Smith, Minneapolis, Minn.

1,136,517. ARTIFICIAL-BREATHING APPARATUS. Johann Heinrich Drager, Lubeck, Germany.

1,136,607. GOVERNOR FOR COMPRESSORS. John L. Osborne, Rochester, N. Y.

1,136,619. FLUID PRESSURE OR FLOW REGULATOR OR CONTROLLER. Ernest Lincoln Sage, Newton Center, Mass.

1,136,827. FAN-BLOWER. William J. Montgomery, Jeannette, Pa.

1,136,877. CENTRIFUGAL BLOWER AND OTHER CENTRIFUGAL MACHINE OF A SIMILAR NATURE. Thomas Henry Collett Homersham, Bradford, England.

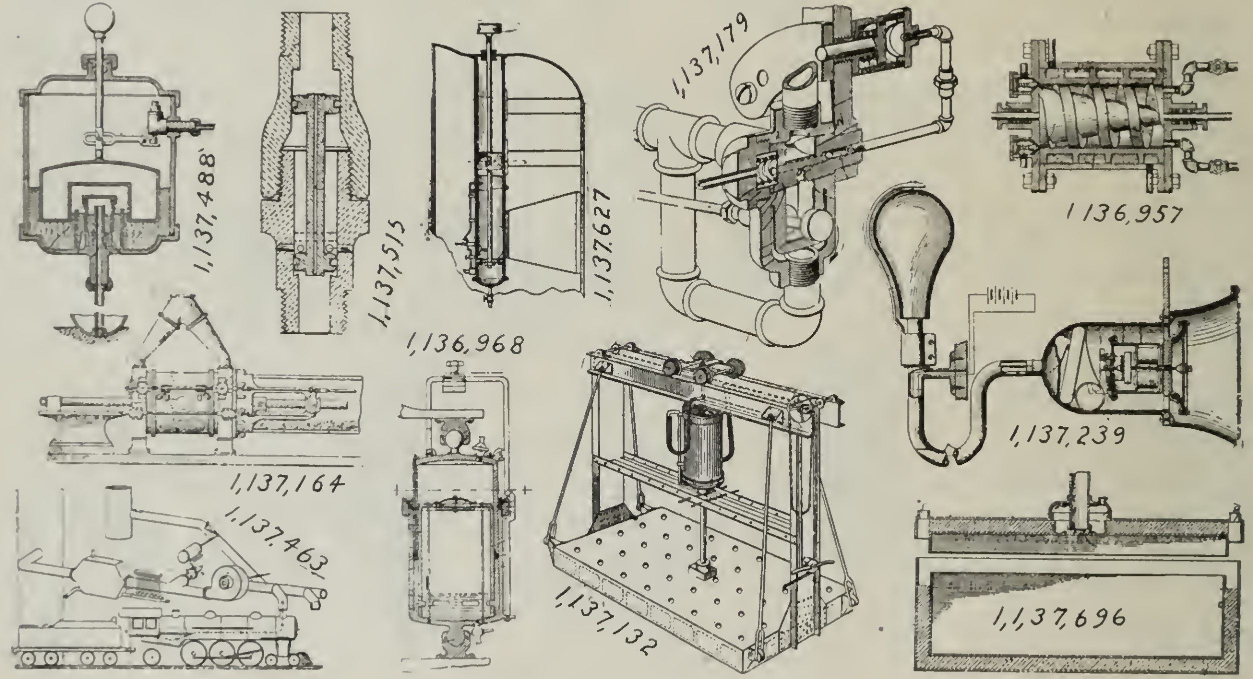
1,136,890. VACUUM CLEANING-MACHINE. George Brand, Brooklyn, N. Y.

APRIL 27.

1,136,923. PNEUMATIC PIANO-PLAYER. Holden P. Ballou, Hartford, Conn.

1,136,957. ROTARY COMPRESSOR. Carl F. Hettinger, Boston, Mass.

1,136,968. PNEUMATIC CUSHION. Charles W. McDade, Moorhead, Iowa.



Pneumatic Patents April 27.

1,137,132. PNEUMATIC PRESS AND METAL-FORMING MACHINE. Edward G. Gross, Columbus, Ga.

1,137,164. SAFETY DEVICE FOR BLOWING-ENGINES. Henry G. O'Reilly, Joilet, Ill.

1,137,179. VALVE MECHANISM FOR AIR-BRAKE SYSTEMS. William Austin, Scranton, Pa.

1,137,239. COMBINED ELECTRIC AND PNEUMATIC HORN. William Sparks, Jackson, Mich.

1,137,304. GLASS-BLOWING MACHINE. Benjamin D. Chamberlin, Washington, D. C.

1,137,327. PNEUMATIC-DESPATCH-TUBE APPARATUS. Chester S. Jennings, Boston, Mass.

1,137,339. ETCHING APPARATUS. Louis E. Levy and Howard S. Levy, Philadelphia, Pa.

1. In an etching apparatus, a tank for etching fluid, means for effecting an ebullition of the etching fluid by the introduction of air into the etching fluid, means for maintaining a plate to be etched so that said plate will be maintained in a fixed position submerged in the etching fluid with the face to be etched downward, and means for effecting a distribution of the air in the etching fluid such means being located beneath the plate to be etched.

1,137,463. BLOWER SYSTEM. Charles W. E. Clarke, New York, N. Y.

1,137,488. SIPHON ATTACHMENT. Francis K. Hyde, New York, N. Y.

1,137,575-6. AUTOMATIC AIR-ESCAPE VALVE FOR RAILWAY-BRAKES. Samuel Cheney, Wickepin, Western Australia, Australia.

1,137,627. FENDER. Walter H. Jennings, Smithfield, Pa. Filed Aug. 12, 1914.

1,137,696. BURIAL-CASE. George L. Campbell, Williamsport, Pa.

1. A burial vault comprising a housing, a closure hermetically sealed thereon, said closure being provided about centrally with a cavity and also having a valve seat in the bottom of said cavity, a valve mounted in connection with the seat in the closure, means to limit the outward movement of said valve, and at the same time permit air to be extracted from the housing, and means applicable to the cavity in said closure for sealing the valve in its seat after the air has been extracted from the housing.

1,137,701. AIR-BRAKE APPARATUS. Frank S. Cravens, Olive Hill, Ky.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

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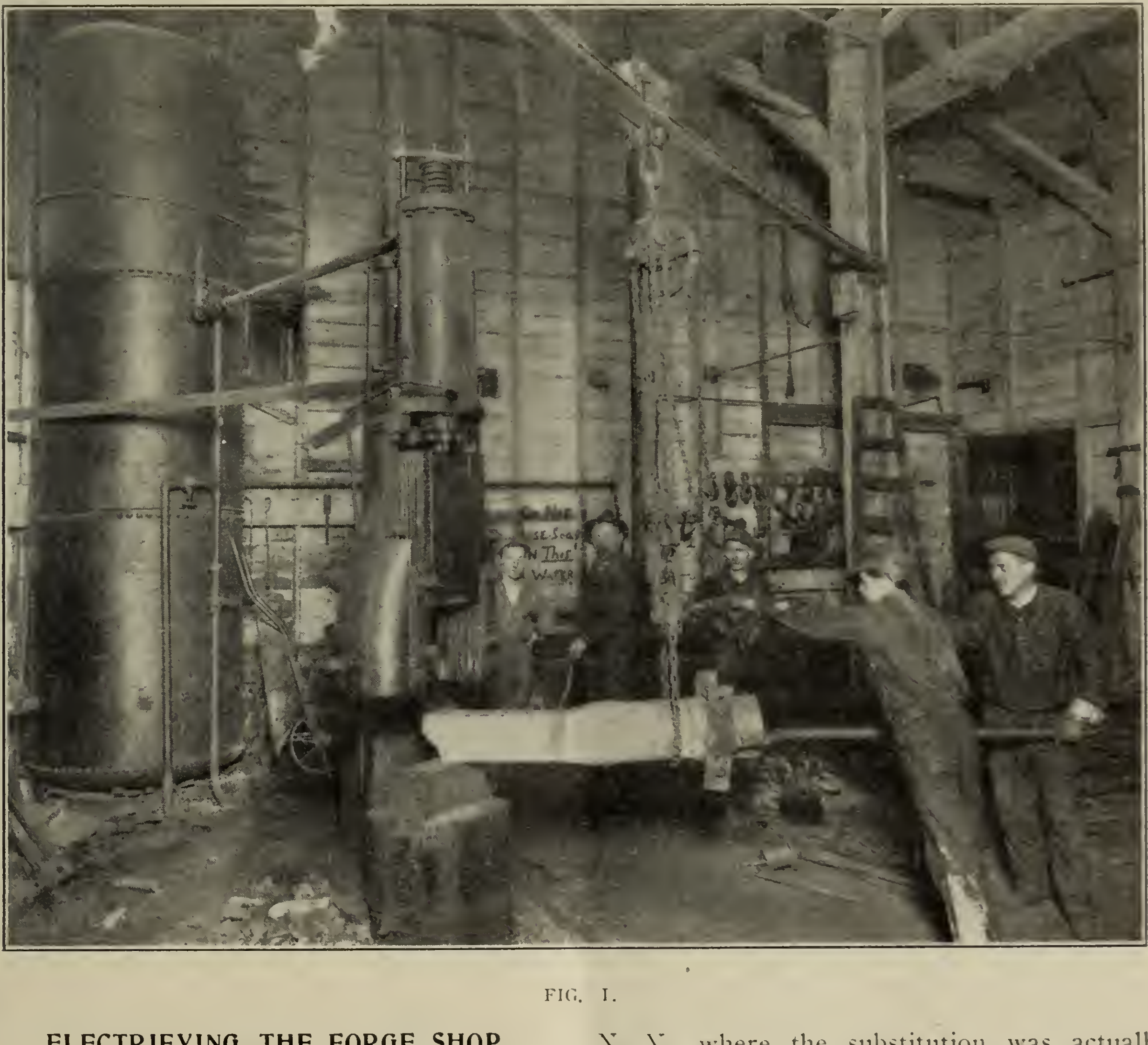


FIG. I.

ELECTRIFYING THE FORGE SHOP

BY CHARLES A. HIRSCHBERG.

This is to tell how steam may be, and is being, dispensed with as a direct motive power in forge shops, the electric current being adopted in its place, and this being made available by the aid of compressed air. We may begin by citing one plant, Buffalo Pitts Co., Buffalo, N. Y., where the substitution was actually made, that is, a steam hammer was converted into an electro-pneumatic one.

Inquiry was made here as to the reasons for the conversion and whether the results had justified the change. It elicited the following reply:

"We have one forge hammer operating under compressed air. It has been very satisfactory but we are sorry that we cannot give you at this time any accurate information as to the amount of power which it takes to operate it."

"The principal reason why we changed from steam was that our boilers were being run here for the sole purpose of operating our one big steam hammer, the rest of the plant being on electric power. By cutting off the steam we have been able to cut out our high-pressure boilers."

The compressed air plant here consists of a motor driven "Imperial" two-stage compressor, and the air in addition to driving the hammer is being used for operating pneumatic portable shop tools.

The Nisqually-Russell Car and Locomotive Works of Tacoma, Wash., were also operating their forging hammers by compressed air, and upon inquiry Mr. A. G. Brown, President and Manager, was good enough to furnish some extremely interesting information and the accompanying photos.

About two years ago (1912) the City Boiler Inspector condemned the boiler in this plant. It was chiefly used to furnish steam for the large hammer shown in Fig. 1. Instead of buying a new boiler the old one was converted into a vertical air receiver and a 14 and 9 x12 "Imperial" air compressor was belted to motor installed to furnish power to the hammer as well as to operate the hand air tools used about the works. The receiver is placed close to the hammer as shown. In converting the steam hammer to compressed air operation the action of the inlet and exhaust valves was improved by giving them a slight taper.

In Fig. 2 is shown the compressor plant, although the relative dimensions are not consistent. Mr. Brown stated that $50.00 a month was a liberal estimate for the power consumption of the compressor, whereas the fixed charges under the old system were $62.50 per month for the licensed fireman at $2.50 per day and $31.25 for 12½ tons of coal at $2.50 per ton, making a total of $93.75, or a saving in favor of the air compressor of $43.75 a month.

The reader should bear in mind that the compressor is operating other tools; therefore the saving in reality would be greater than the figures above show. On the above basis, however, the saving per year in this plant is $525.00. This company further stated that aside from the saving there is a decided advantage in the increased efficiency of the hammer as they were only able to carry 90 lbs. pressure on the old boiler and they figured that this gave them about 60 lbs. working pressure at the hammer. The air, on the other hand, is practically at the same pressure at the hammer as in the receiver, and they get fully 90 lbs. on the piston. The further statement is made that "the air is quicker, and although not so elastic as the steam (?) is nevertheless very satisfactory."

A further saving might be mentioned in the expense of handling the ashes which they have to cart away. So far as the item of cost for boiler feed water is concerned, this is about offset by the consumption of the cooling jackets of the compressor.

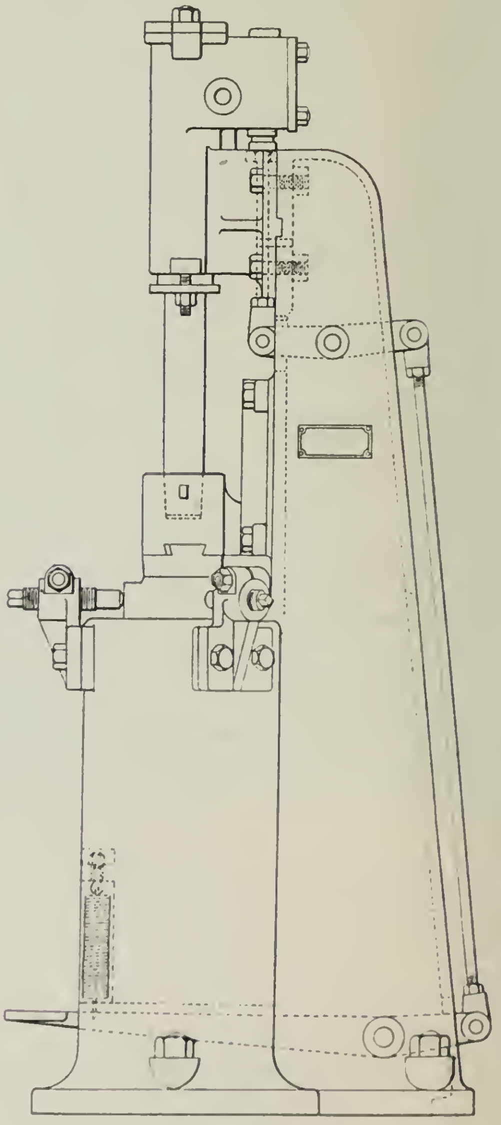


FIG. 3.

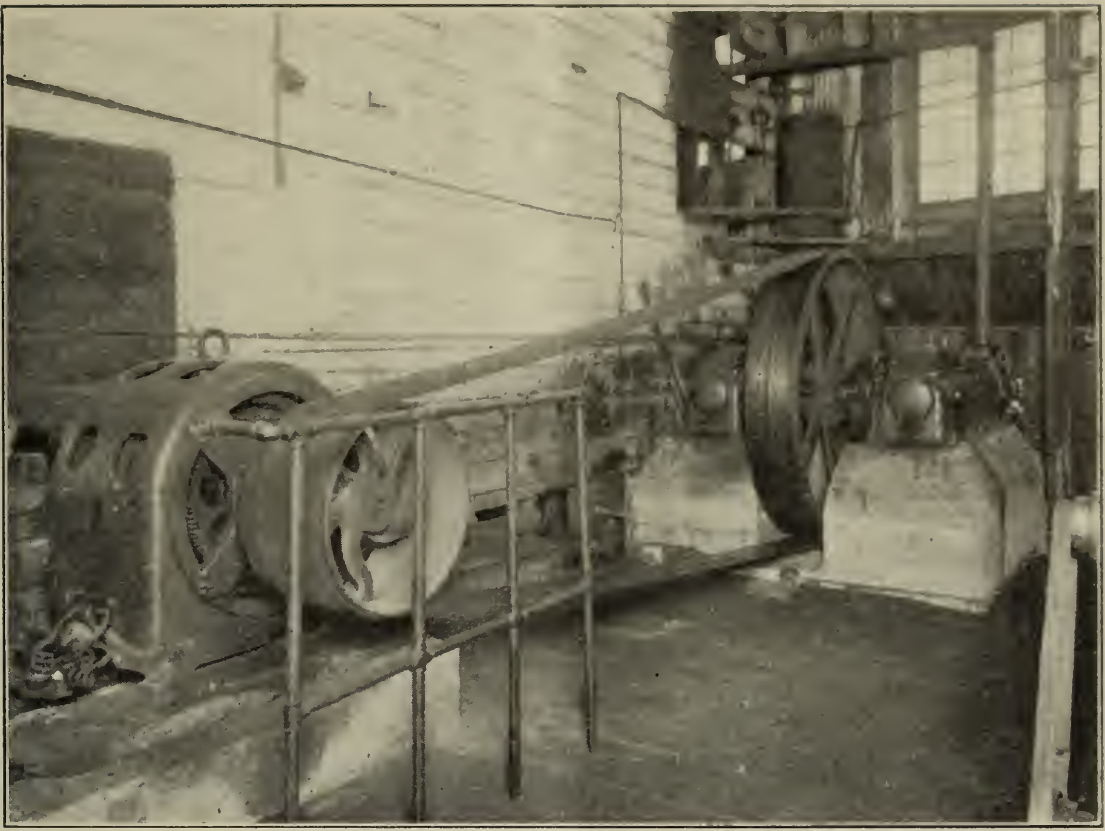


FIG. 2.

The Herbrand Company of Fremont, Ohio, have recently installed several compressors for operating converted steam hammers; they have not however been long enough in service to draw a comparison between present and past practice.

Manufacturers of forging hammers have become awake to the conditions existing and within the past few years there have been a number of hammers placed on the market designed especially for operation by compressed air.

In Fig. 3 is shown a pneumatic drop press built by the Henderson Machine Co., of Philadelphia. It is designed for stamping sheet metal hot. Sizes range up to 46″ x 72″ face of hammer. The power consumption ranges from 60 cubic feet of free air per minute, for the smallest size, to 200 cubic feet for the largest at a pressure of 90 pounds.

Fig. 4 shows another pneumatic drop hammer, built by the Pennsylvania Pneumatic Co., Erie, Pa. The builder's object in designing this tool was to eliminate the board, friction rollers, gears, clutches and other such appurtenances which mark the ordinary steam drop hammer, and to take advantage of the convenient compressed air power, making it possible to greatly simplify the design and in addition give more satisfactory operation. Compressed air at a pressure of 60 to 100 lb. is used, striking a blow of between 250 and 350 lb. The manufacturer claims an unusually low air consumption of about 3 cu. ft. of free air per minute at 60 lbs. pressure or about 5 cu. ft at 100 lbs. pressure.

A FEW ADVANTAGES OF THE PNEUMATICALLY OPERATED HAMMER AND DISADVANTAGES OF STEAM OPERATION.

Compressed air is lively and instantly available for use, so that there is no delay when starting up in the morning, or any time it may be wanted.

When starting up the steam hammer it is usually cold and the steam condenses, the lubrication is partly washed out, and there is a lot of water dripping, so that you cannot put a forging under the hammer at once. If you do that, dripping water is likely to spatter and scald the operator. Nor can the forging always be left in the fire, waiting for the water to stop dripping, because it is liable to burn, and all this trouble happens several times a day unless the hammer is in constant use. Then there is constant trouble from burnt out packing.

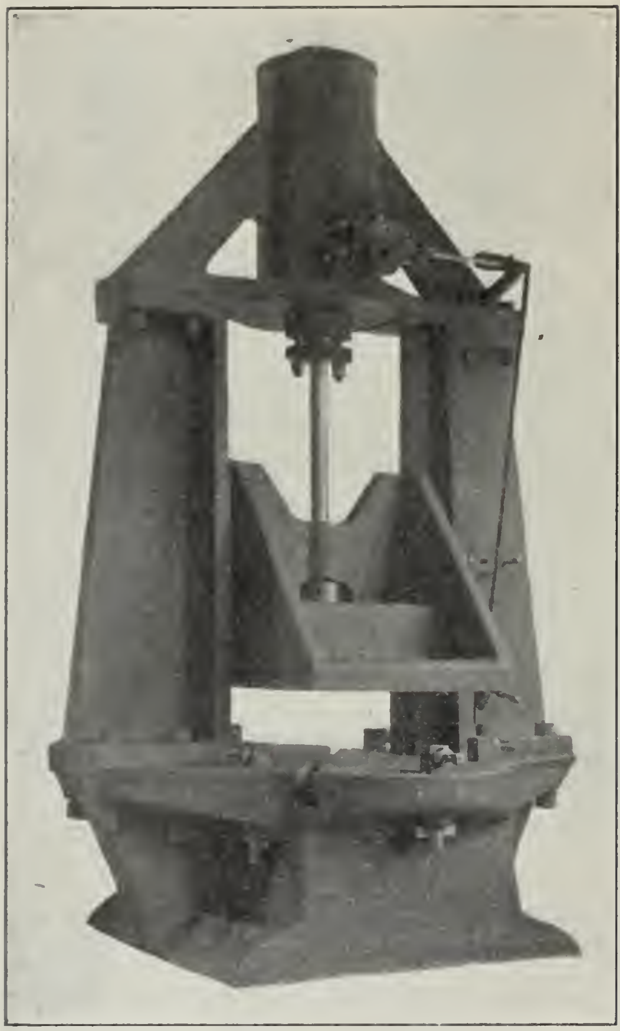


FIG. 4.

OTHER USES FOR AIR IN THE FORGE SHOP.

In many forge shops the compressed air is utilized for blowing forges, oil furnaces and tempering furnaces, for agitating various tempering liquids, for operating hoists, bull-dozers, bending presses, bolt heading machines and various other pneumatic devices and portable pneumatic tools.

The average machine shop is already familiar with the advantages of compressed air in shop operations, but in the case of the forge shop it would seem to warrant special consideration.

LEAD WOOL AND PNEUMATIC CAULKING

At the recent annual meeting of the American Water Works Association the comparative merits of lead wool and of cast lead joints were discussed, and it was shown to be greatly advantageous to use the lead wool, especially where only a few joints are to be made at a time.

Mr. John M. Diven, superintendent of water works at Troy, N. Y., stated that he has found the use of lead wool so satisfactory that, in small jobs, such as in setting fire hydrants where there are only four or five joints to make, he has not used a fire for years. He called attention to the fact that the time required to get the fire started and to get the melting apparatus in position, in the case of a small job, is a large percentage of the time required for the entire job, and is correspondingly expensive. On one large job he stipulated with the contractor that a half mile of pipe be laid with lead wool and hand caulked joints and a mile with air pressure joints. A careful record of the leaks in both types of joints was to have been kept, but the contractor's caulkers refused to do the work and the test was given up.

This is not the first instance in which caulkers have refused to use the pneumatic tools. The refusals have not been at the suggestion of "organized labor" or anything of that kind, but have been on account of the inexperience and timidity of the workmen. Where the use of the pneumatic tools has been demonstrated by experts, and where it has thus been shown that the work is actually easier and more remunerative the tools have come to be preferred, as has occurred in Brooklyn and elsewhere.

On another occasion Mr. Diven states that he had laid an 8-in. cast iron pipe line through swampy land. One-half of this line was caulked with lead wool and the other half with cast lead joints. Seven or eight months after the work was done there had been no leaks in the lead wool joints but all of the cast lead joints had developed leaks. The joints were all very deep and were from ½ to ¾ in. thick, and the lead wool held where the cast lead did not.

Mr. Oscar Bulkley, engineer of the Rockford, Ill., water department, stated that in his department lead wool was used on a line of pipe 8 and 10 ins. in diameter, but the use of the material was abandoned because the caulkers refused to do the work. When caulked by hand it is a long and tedious job. The only way lead wool can be used to advantage on big jobs, is in connection with pneumatic caulking.

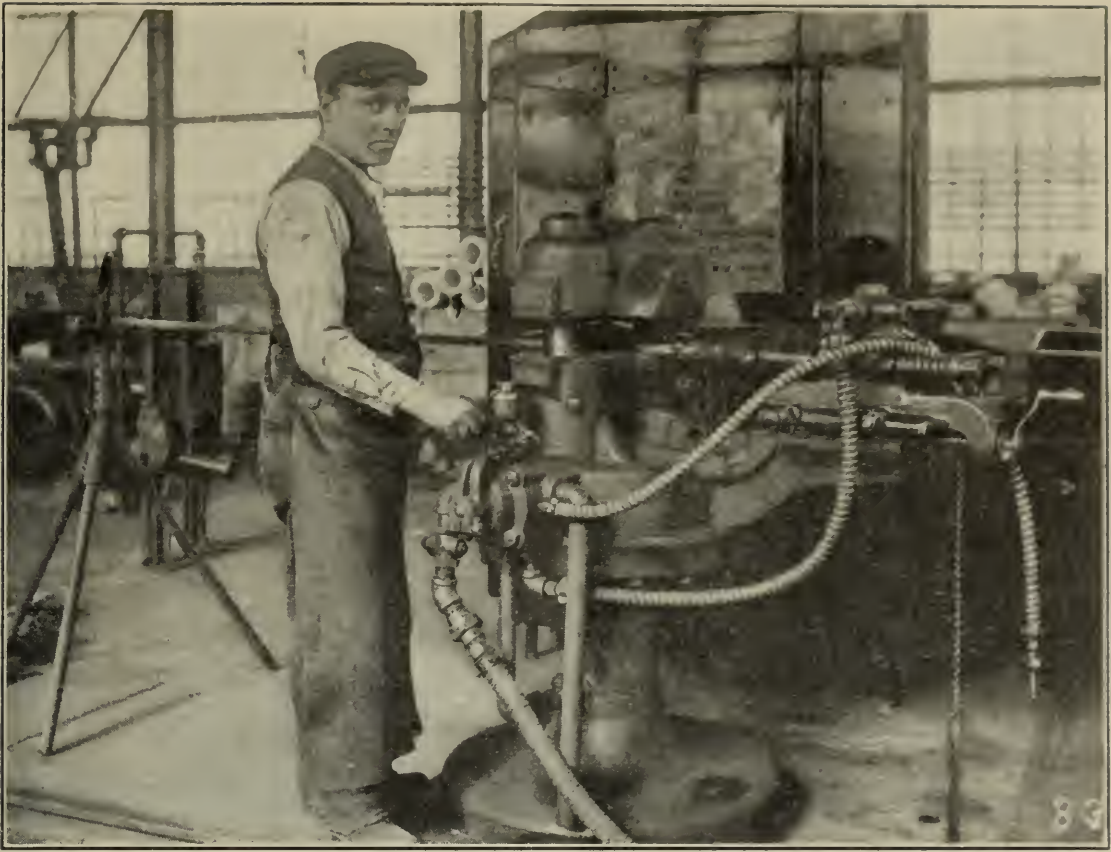


FIG. I. GENERAL VIEW OF LEYNER SHARPENER.

JACKHAMERS DRIVE GANGWAYS IN ANTHRACITE MINES

BY CHARLES C. PHELPS.

This article refers to the results obtained in mining anthracite coal by the use of Jackhamers and electrically driven mine-car compressors by one of the large coal-mining companies operating in the Scranton district of Pennsylvania. One of the collieries of this company was recently visited by the writer after the above-named equipment had been in service about seven months.

The mine car compressors employed here are of the Ingersoll-Rand type, and the Jackhamers also are Ingersoll-Rand B. C. R.-430, both of which have been described in these columns and elsewhere, so that it will not be necessary to go into a detailed description again. A large number of these equipments are in use in the various mines of this company for drilling both coal and rock, also for cutting hitches for timbers.

Formerly hand coal augers were used for boring the coal, while Temple-Ingersoll electric-air drills, as well as hammer and "jumper" steel, were employed for the rock. Whereas two men were required for either machine or hand drilling, as formerly practiced at this mine, it now requires but one man to run a Jackhamer drill, as this machine is easy to operate and, owing to its lightness, may be moved from place to place almost as easily as a shovel or a pick.

One feature of the Jackhamer that is particularly appreciated by the drill runner is the improvement in the ventilation at the face due to the air exhausting from the drill.

Although some of the holes are drilled downward, most of them are projected horizontally for blasting from the solid. Probably three out of every four holes are horizontal. The blast holes are drilled to a depth of 6 ft. with changes of steel varying by a foot. A set comprises lengths of 2½, 3½, 4½, 5½ and 6½ ft. of hollow hexagon steel with cross-bits of such size that the bottoming diameter permits charging with ⅞-in. 50-per cent. gelatin powder. Holes were formerly put in to the same depth and the same strength powder was used, but the holes were of 1½ in. diameter.

With conditions as mentioned above, the rate of progress during one month was 225 ft. of gangway driven, working with one Jackhamer during two 8-hr. shifts per day and driving a section 14 ft. wide comprising 3 ft. of anthracite coal and 4 ft. of bottom sandrock. The rate of drilling of the Jackhamer in hard coal was observed to be 3 min. for a 6-ft. hole, including changes of steel. It required 10 min. to drill a 6-ft. hole in the sand rock, also including the changing of steel.

The mine-car compressor is transported over the regular mine tracks to a point near the face. It is then derailed and placed to one side and connected with the electric line supplying the trolley system. The drill-runner also cares for the mine-car compressor, no other attendant being required. In fact, about the only attention required by the compressor is an occasional filling of the water jacket, which is of the hopper reservoir type, and replenishment of lubricating oil. In other respects the compressor is entirely automatic in action, an automatic unloader keeping the pressure in the receiver at approximately 100 lb.

The 25-hp. motor which drives this compressor is started and stopped with an automatic motor starter, which is a new development, as hand-operated starters have been employed previously for starting machines in this service. The hand starter has the shortcoming that it depends for successful operation upon a certain amount of skill on the part of the operator, and as these equipments are often handled by inexperienced men, it is difficult to prevent abusing the motor when the hand type of starter is employed. With the automatic starter, the knife switch is closed in order to start up, whereupon the motor is smoothly but quickly accelerated to maximum speed. The knife switch is opened when the compressor is to be shut down.

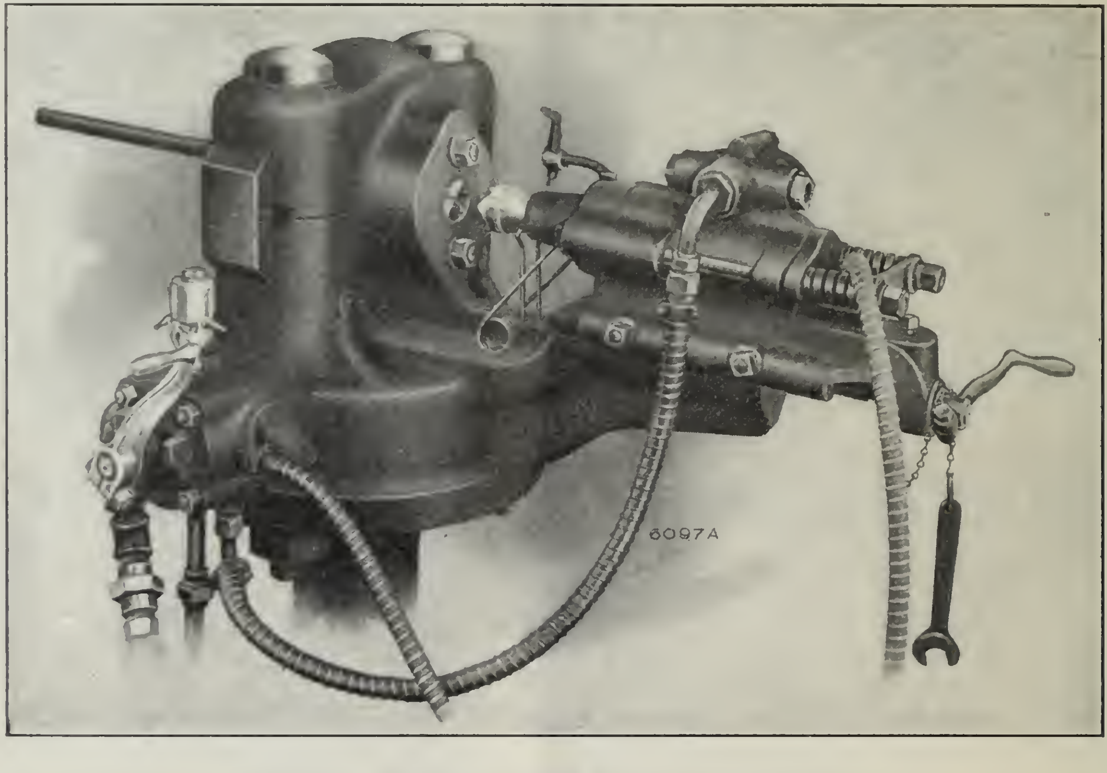


FIG. 2. DOLLY SHARPENING A DRILL POINT.

The automatic motor starter may be seen in Fig. 3 showing the compressor car. It is known as a form AK made by the Electric Controller & Manufacturing Co. The copper contacts are protected by dirt-proof covers, which also help to exclude the corrosive gases that are present in coal mines. On account of the extremely wide range of voltage found in the average mine these starters are specially designed to keep the motor across the line, even when the voltage drops to a very low figure. An added advantage of using automatic starters lies in the fact that if power is interrupted the motor will be gradually restarted without further attention when current is again restored.

The steels used while making the observations referred to were sharpened by hand. Since that time several Leyner drill sharpeners have been purchased for the company's

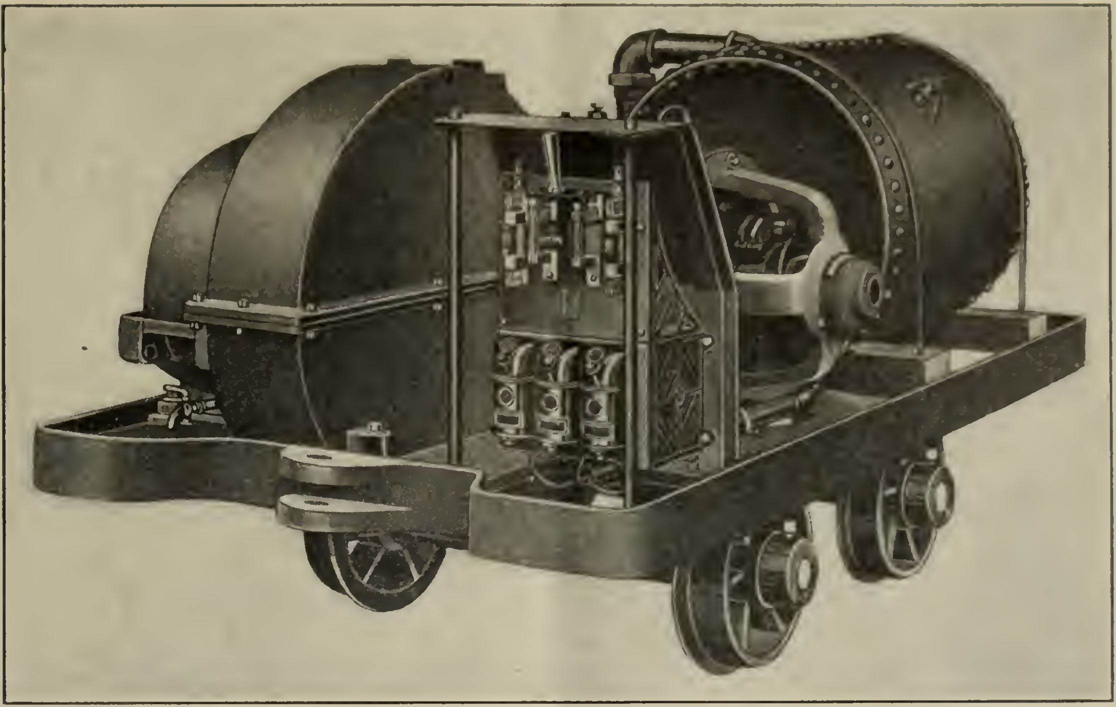


FIG. 3. MINE-CAR COMPRESSOR WITH AUTOMATIC STARTER.

various mines. One of these is shown in Fig. 2. Three coal forges located near the sharpener are used for heating the steels. The bit is first inserted between the forming blocks, and the heavy cross-head forges the bit to approximate cross-section. It is then inserted in the dies in the center of the machine and the cross-head is lowered to grip the steel tightly. The dolly then reciprocates rapidly, striking the end of the bit a succession of light blows, compacting the metal and sharpening the bit.

The sharpener is operated by compressed air, and its action is controlled entirely by the single lever shown in the illustration. After sharpening, the steel is reheated to a cherry red and hardened by dipping in a pail of water upon the surface of which floats about ½ in. of crude oil. The shanks are formed in the same machine and are hardened for a distance of about ¼ in. from the end.

By means of the Leyner sharpener the time required for sharpening steel is greatly decreased, giving the blacksmith more time for other duties. At the same time a much better and more uniform quality of work is obtained. The method of hardening described has proven satisfactory, resulting in very little broken steel.—*Coal Age.*

Tanks to hold half a ton of ice and electric fans to circulate the air from them are used to cool the interior of passenger cars of the Egyptian State railways.

POWDER EXPLOSION PHENOMENA

It is curious how differently powder acts under conditions apparently similar. I have been at the side of a man carrying a box of powder, when it fell and did not explode. Again, I have known it to fall from a man's shoulder and kill every one near-by. I once had a mule loaded with grain and 100 lb. of powder; the cargo became loose and frightened the mule, which ran away, scattering the powder for a hundred yards and even breaking sticks of it, but without any explosion. A number of years ago a pack-train of 22 mules loaded with powder out from Mazatlan, Mexico, disappeared. It is presumed a box fell off when loading. At any rate the whole pack-train, including the men, was killed. The remains proved insufficient for burial.

Once a partner of mine was thawing powder at an open-air fire while we were eating dinner. It caught fire and as we needed that powder badly, he grabbed a shovel and deliberately beat the fire out with it. I yelled, trying my best to stop him, and then, as he kept on, I ran: but there was no explosion. Later his carelessness caused the loss of his eyesight. While working in a 240-ft. tunnel we tried to fire six holes at the breast. One would not spit and, after lighting the others, we again tried to ignite it, but were finally obliged to run. The fuse still declined to spit, and the result was a misfire. My partner insisted on returning (probably 6 to 8 minutes

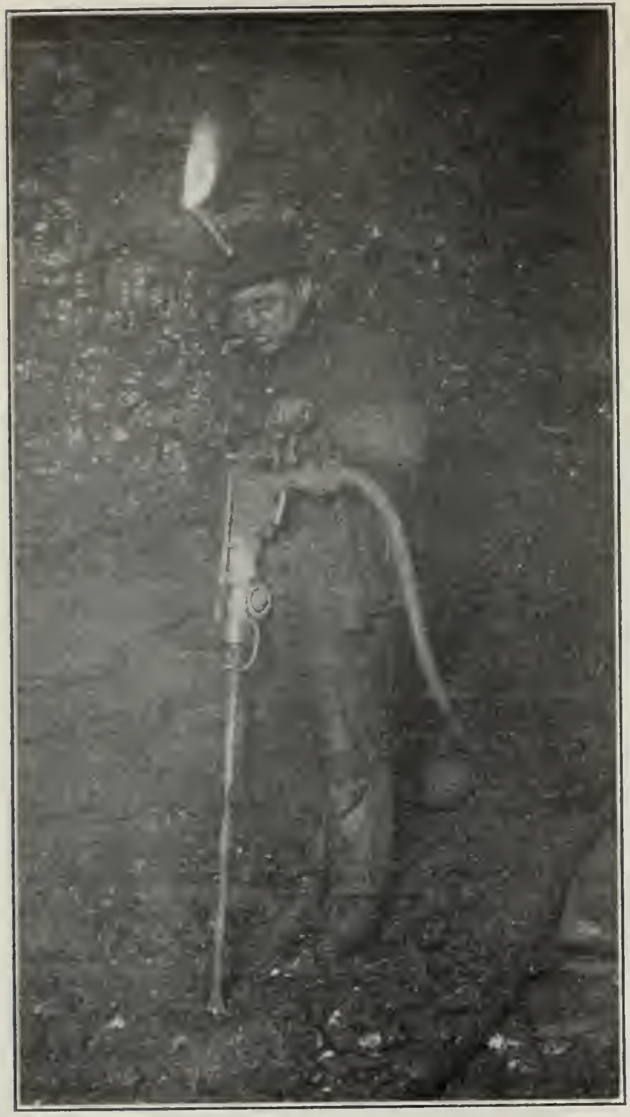


FIG. 4. STARTING A HOLE.

later) to re-light it, while I built a fire to warm our coffee. I tried my best to persuade him to wait until after dinner, but he went and was just over the hole when it exploded. This fuse, examined afterward, showed no evidence of having been burnt.

A friend had an experience with defective fuse in the bottom of a shaft. The fuse would not light. He and the others waited the full noon-hour, when, upon entering the shaft, it exploded. I have known an ignorant man to throw powder down a 40-ft. shaft to a miner without its exploding. That miner, however, did explode; climbing the ladder, he chased the other man off the property. The latter never returned. I have seen boxes of powder thrown down a bank, 60 to 75 ft. high, sometimes breaking the boxes, and still without exploding. I have seen loose sticks thrown from one car to another loaded with rocks and bounce off the car without exploding. Again, powder has been known to explode from a very slight shock or fall.

I have seen two or three tons of powder burn up without explosion and again have seen it explode from the heat of a stove while being thawed. A few years ago a ship-load was lost at the entrance to the Bay of Altata, at Sinaloa, Mexico, and after several months it was salvaged. It was so badly damaged that new powder had to be used with it in order to make it explode, but, the price of powder being high, it was all used.

The action under similar conditions of powder of the same make and strength is so different, that the utmost care should always be exercised when handling any explosive.—*G. L. Sheldon in Mining Press.*

AN EXPLOSIVE MIXTURE AND WHAT IT DID

BY NAT. G. PUMPER.

There was a compressed air tank used by a large pumping plant to start their gas engines. The tank, which was located outside the auxiliary room, was 60 in. diameter and 20 ft. long, tested to 200 lb., the compressor for charging was too small for the purposes and in an emergency a one-inch line from the high-pressure gas line was tapped in. The tank would be charged up to about 130 lb. and the engine started, then the tank would be blown clean and filled with air by the compressor.

This went very well for awhile, but one day the auxiliary engineer blew the tank down to atmospheric pressure, closed the outlet valve and proceeded to pump with air till he had 130 lb. gage and a beautiful mixture in that tank. A few hours later, another engine was to be started, everything was ready, the "air" was turned on, ignition switch pushed in and then one of the starting valves stuck open. That tank started 3 ways at once, the middle sheet straightened out flat and went about 4 ft. into the ground, cutting off a 10-in. line, one end started east, taking a 6-in. engine feed line with it and the other end went the other direction, landing in a bank of 16-in. gate valves which it demolished. A large farm house 120 yards away was moved off its foundation and the plant was wrecked generally, and now they start with air.—*Practical Engineer.*

COMPRESSED AIR FOR FLOATING AND REPAIRING STRANDED SHIPS

BY HERBERT B. SAUNDERS.

It has been my privilege during the last twenty years to be very closely associated with salvage work, and during this period I have been able to observe very closely the different methods that have been employed by several salvage contractors as they have wrestled with the difficult engineering problems. Some have employed methods which were very crude and even amusing, while others have gone to work with a skill and energy which have produced most remarkable results. Probably the method which has appealed to me more than any other has been the use of compressed air, not only with ordinary salvage operations but for construction work such as the laying of foundations by the aid of the pneumatic caisson.

THE SCOTTISH KING.

Some sixteen years ago the steamer Scottish King, on a voyage from Antwerp to Baltimore and laden with a valuable cargo, stranded on the eastern shore of Newfoundland. Various efforts were made by local companies to release her, but with no success. Then Captain William Leslie of Kingston, Ontario, came with the wrecking steamer Petrel which had an air compressor as part of her equipment, and by its aid, in combination with that of powerful water pumps, the vessel was floated and taken into St. Johns, where she was temporarily repaired and sent to the St. Lawrence. There she loaded a cargo of lumber for the United Kingdom, but due to various mishaps the venture was not a financial success, and so for the time being enthusiasm over the salvage means employed was dampened.

I had carefully watched what had been done by Captain Leslie and was impressed by the methods employed, but also that these methods could be improved so as to secure economy and despatch. It will be readily appreciated, however, that opportunities in this line are not frequent, and that improvement depending upon actual experiment must be slow.

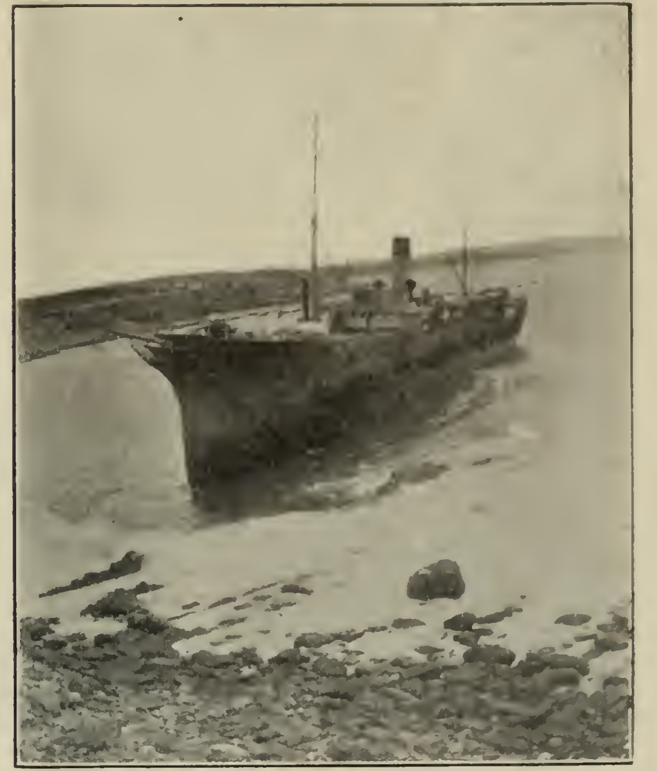


FIG. I. SCOTTISH KING, NEWFOUNDLAND, 1899

The next case which presented itself was upon a large steamer that stranded in the West Indies, and the only apparatus available was a hand operated diver's air pump. The forward compartments were full of water to sea level. The air hose was attached to the air pipe at the forward end of the tank and in a very short time the trouble was found. The diver was sent down, the holes were plugged and the compartment pumped out. In a short time the other damaged parts of the vessel were located from the outside, stopped, tanks pumped out and valuable vessel was saved.

Shortly after this the British steamer Ben Cruachan while on a voyage to the St. Lawrence stranded to the eastward of Louisburg, C. B., harbor. It was high water when she stranded and blowing a fresh S. E. gale, so that the vessel was forced well up on the rocks. I succeeded in persuading the contractor to apply compressed air as the main agent in saving this vessel. He brought his plant alongside the ship at noon on Friday and the following Tuesday evening all was ready for trial. The preliminary tests were successful, so that when the air was applied the next morning at high tide the vessel was readily released from her rocky bed. She was taken into Louisburg where sundry repairs were made and the next day she was able to proceed under her own steam to Halifax, and there she was dry-docked and repaired and turned over to her owners in as good condition as before the mishap.

The next experience in this line and equally satisfactory was with a large Italian steamer on the Florida Keys. It was nearly a repetition of the work done on the Ben Cruachan.

The author of this paper having watched the work done by the different experts and seen the advantage of compressed air for this service, has continued experiments and applied certain improvements in practice.

When the water has been expelled by the pressure of the air and a patch is to be applied from within over a wound by which the water has entered there usually is at this point a violent pulsation between the air inside and the water outside, which makes it practically impossible to get concrete, or any other kind of jointing material to set properly. The surging causes the concrete to become honeycombed, with the result that the patch thus applied is considerably weakened, and often when the air pressure is removed the patch all gives way, and the work has to be done all over again.

This trouble so serious and often so costly to the contractors is overcome by the simple method here outlined. A piece of large pipe is provided (Fig. 2) threaded on each end with one end screwed into a large flange and a cap ready to be screwed on to the other end. The water having been expelled by the compressed air, and the air pressure being maintained within the compartment, a sheet of lead, forming an apron is spread over the wound, overlapping it all around, and then the flange is placed over the lead and secured from moving by wooden dowel pins. A hole is punched through the lead right at the wound so that the water outside has free communication with the interior of the pipe, the upper end of the pipe remaining open.

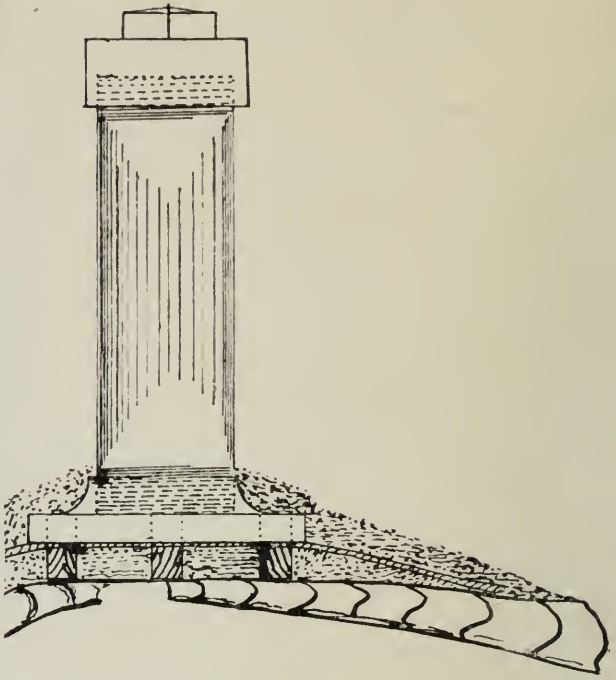


FIG. 2.

Concrete is then applied over the entire patch, starting at a reasonable distance out-

ROYAL GEORGE, ORLEANS ISLAND, 1912.

URANIUM, CHEBUCTO HEAD NEAR HALIFAX.

side the water edge of the lead apron and working in toward and around the pipe, and as thick as may be required to insure sure resisting power against the upward pressure that must come against it as soon as the internal air pressure is removed. The pipe referred to can be used singly or in series, according to the size of the wound and the thickness of the patch. When the concrete has securely set the caps must be screwed on to the upper end of the equalizing pipe or pipes, this effectually preventing the inrush of water.

The next point to be overcome was the fogging caused by the heated air being forced into the compartment under pressure. This was taken care of by an effective aftercooler which reduced the temperature after compression so that the air was comparatively dry and free from fog.

The results obtained were satisfactory, for previous to these experiments great trouble was experienced from the starting of the deck joints caused by the sudden rising and falling of the temperature and pressure, and the unsatisfactory work that was done under the difficult conditions.

We can now refer to the salving of the Royal George (Fig. 3), a mail and passenger steamer of about eleven thousand tons register operated between the St. Lawrence and Bristol, G. B., by the Canadian Northern Steamships, Ltd. This vessel stranded on her last, 1912, voyage to Montreal, a short distance below Quebec. Various efforts were made to release the vessel which was seriously damaged and forced well up on to the rocks of Orleans Island, but the owners abandoned their interest in the vessel to the underwriters

URANIUM IN DRY-DOCK.

and their experts employing the methods here outlined soon released the vessel. There were several patches put on from the inside which allowed several of the compartments to be pumped out and then she was floated. Later she went into dry dock and proper patches were put on the outside.

The next case, more difficult and trying, was that of the S. S. Uranium. This vessel stranded, early in 1913, in the vicinity of Chebucto Head at the entrance to Halifax Harbor (Fig. 4). She was severely damaged from her stern to the second transverse bulkhead but was successfully floated and taken into Halifax, where as no dry dock was available she was so patched *from the inside* by the aid of compressed air and the system of concrete patching that she was able to reach New York under her own steam. Fig. 5 shows the bow of the steamer in Robbin's Dry Dock, South Brooklyn, where she was properly repaired.

LIQUID AIR AS AN EXPLOSIVE

The following is an abstract, presented in the Journal of the American Society of Mechanical Engineers from *Zeits. für Eis—und Kälte—Industrie.*

Professor Linde appears to have been the first to successfully introduce an explosive consisting of ground charcoal and liquid air. Since then Claude and d'Arsonval, in France, have further developed these processes, and finally Kowatsch and Baldus, in Germany, have lately worked it out still more fully, partly under the pressure of the present demand for an explosive exclusively of German manufacture.

In order to avoid excessively rapid evaporation of the liquid air, Kowatsch, who uses a cardboard cartridge, introduces first a cartridge with dry carbon into the drill hole separately and without any liquid air, which is put in only just previous to ignition. The process permits reducing to a minimum the period of evaporation, and also increases the factor of safety of operation.

The cardboard cartridge contains a perforated pipe in which there is a mixture of infusorial earth with oil and asphaltum or lamp black and parafin, neither of which is explosive in itself. This center pipe contains another cardboard tube over which a third cardboard tube is set, serving as an exhaust pipe for the products of evaporation of liquid air. If several drill holes have to be exploded simultaneously, the electric connections are made accordingly.

The liquid air which has to be used for each hole is kept in a precisely determined quantity in a small bottle, the opening of which is provided with a metal tube and conical nozzle, connected with the central tube of the cartridge. To load the cartridge, all that is necessary is to lift the rear end of the bottle. The liquid air is raised by the pressure of its own products of evaporation and gradually passes into the cartridge. At the instant when the charge is ignited by the electric spark, the liquid air combines with the charge and there follows an explosion of exceptional violence.

Among the advantages of this method of explosion is the fact that, in the first instance, the materials used are not explosive in themselves and the explosive mixture is formed only at the very last moment in the bore hole itself. In the second place, should an explosion be missed, the liquid air will evaporate and the remaining cartridge is perfectly harmless.

SAILOR'S LIFE SAVED BY OXYACETYLENE TORCH

When the salvage ship "Salvor I" turned turtle off the English coast near Yarmouth, all the crew were washed away and drowned except one man who found himself uninjured but imprisoned in the forecastle. The vessel had turned so quickly that there was plenty of air impounded, so he was in no immediate danger of drowning or suffocating. Every time the vessel rose with the swell one of the portholes rose clear of the water, and, stationing himself at the opening, the imprisoned man stuck his arm out and waved his hand each time this occurred. After three hours he heard a slight tapping on the hull, a head was stuck in at the porthole and a voice said "Where shall I cut open the hull?" After showing the rescuers how to keep clear of the stancions the imprisoned man lost consciousness, but had a vague realization of being gripped by the neck later and pulled out of the hull. An opening big enough to pull the man through had been cut in the steel hull with an oxyacetylene torch, the rescuers standing neck-deep in water for an hour while doing this work.

DANGERS AND SAFETY CONDITIONS OF HIGH EXPLOSIVES

The detonation of nitro-glycerine and its compounds, among which the best known are dynamite and gelatine-dynamite, can only be brought about by one of the two following causes: First, the elevation of the temperature of the nitro-glycerine to its explosive point, namely, in the neighborhood of 400° F., but this does not apply to the entire mass of the nitro-glycerine; it is only necessary for the smallest particle of nitro-glycerine. The heat liberated by the explosion of this smallest particle is quickly communicated to the adjacent particles and progressing with lightning rapidity, in geometric ratio, detonates the entire mass as if by a single impulse. Second, by the synchronous vibrations responding to a wave of detonation set in motion by an exploding mass of nitro-glycerine. This second cause may perhaps be referred to the first; for sound, heat, and light are all forms of energy and are convertible.

Strange stories are often told regarding the erratic behavior of dynamite, and a veil of mystery is generally thrown about the resulting accidents. These stories are often correct, but there is no mystery. It must be borne in mind that dynamites, even those of the same grade or degree of strength, are often not the same, that is, they differ in composition. Again dynamites of identical grade and composition often differ as to their physical properties. For instance, take two dynamites of the same composition, in the one that is the drier the "dope" ingredients are further away from the saturation point; this will render it less sensitive than the other.

The question is often asked what makes a dynamite sensitive. Instead of answering this question, let us consider how a dynamite can be made less sensitive. When nitro-glycerine—a heavy liquid—was first discovered it was used as such and it was soon found that it was far too sensitive. Nobel incorporated kieselguhr, or infusorial earth, with nitro-glycerine and called this compound "dynamite." The modern dynamite contains an active absorbent, one that enters into the combustion of the explosive, and is ever so much more powerful than a kieselguhr-dynamite with the same percentage of nitro-glycerine. It is superior in every respect but one, and that is, it does not hold the nitro-glycerine as firmly as the infusorial earth did.

What is it then that renders a nitro-glycerine compound permanently less sensitive? Here again we have two causes: First, anything that dissolves in, remains with, and dilutes the ultimate particles of nitro-glycerine. When once in solution and with the proper solvent there cannot be any stratification. This insures less friction between the ultimate particles of nitro-glycerine and then, again, these particles will be hampered in their effort to vibrate synchronously in response to a detonating wave. Second, anything that will dissolve in, become a part of, and hold rigid the ultimate particles of nitro-glycerine, preventing friction and hampering vibration, will render the nitro-glycerine less sensitive. This is accomplished by collodion cotton dissolving in nitro-glycerine and converting the same into blasting gelatine or, with "dope" into gelatine-dynamite.

Dynamites are not the same, neither as to chemical composition nor as to physical condition, and the latter is largely influenced by atmospheric conditions—temperature and barometric pressure. All explosive phenomena must be referred finally to an elevation of a particle of nitro-glycerine to the explosive point. This may be occasioned by a sharp blow or fracture of a frozen crystal of nitro-glycerine or the gradual storage of heat generated by some slow process of oxidation akin to spontaneous combustion. The "dope" materials are in general bad conductors of heat.—*Harry East Miller in Mining Press.*

AIR LIFT INFORMATION

BY C. M. WETHERILL.

While it is conceded that the air lift is not as economical as other systems for general pumping, under certain conditions it has proven economical and satisfactory; especially where the water is taken from a well that is less than 12 ins. in diameter and the pumping level of the water does not exceed 225 ft. above the lowest water level in the well. The advantage of the system is that the machinery is all above ground. There is nothing in the well to get out of order and so call for "pulling the well," which so often occurs with the plunger type of pump. The efficiency of the air lift after years of service remains the same, while wear of plunger pumps often causes a drop in efficiency of from 40 to 50 per cent. particularly if the water contains fine sand.

The air lift system has its principal use when the quantity of water is the chief concern, and where it is to be taken from small wells widely separated, and where the cost of operation is not a large consideration. It is the best system of pumping for taking a large amount of water from the small well.

The air lift is a desirable system in small towns securing their supply from deep wells of small bore, especially when electric power is used. The system may be installed to operate automatically, and the plant may be taken care of by the town marshal. In water works of this class the water is brought to the surface reservoir with air. Then it is taken up by a triplex or centrifugal pump, operated by an electric motor, and elevated to the gravity tank. Both of these machines can be operated by automatic float switches.

SUBMERGENCE.

In piping a well it is important to have the proper amount of submergence. This should be between 50 and 65 per cent. of the total length of the eduction pipe; about 60 per cent. seems to give the best results in general. This submergence regulates the necessary running air pressure.

Let us suppose the well is 400 ft. in depth. It is assumed that when pumping the quantity of water wanted the water level in the well will drop 75 ft. below the surface of the ground. The elevation above the surface of the ground is 25 ft., making the total lift above the water level in the well when pumping to the point of discharge a total of 100 ft. Assuming that the submergence should represent 60 per cent. of the entire length of the water discharge pipe, this lift represents 40 per cent. Multiplying this total lift of 100 ft. by 1½ gives 150 ft., which is the 60 per cent. submergence required. Adding the 150 ft. submergence to the 100 ft. lift gives the total length of 250 ft. of water discharge pipe.

EXTREME LIFT PRACTICABLE.

It must be borne in mind that the limit of practical utility to which the water can be raised by this system is 225 ft. above the lowest water level in the well. This covers the majority of cases, although under especially favorable conditions water has been raised as high as 260 ft. above the level of the well. It is not safe, however, to count on a higher lift than 225 ft. except under very favorable conditions.

"SLIP" AND HORIZONTAL PUMPING.

The principle on which the air lift works is that the mixture of air and water in the discharge pipe is lighter per unit volume than the same volume of water outside the eduction pipe. Therefore the mixture in the eduction pipe will be forced to a much higher elevation than the depth of submergence. In the upward motion of the mixture, or alternate pistons of air and water, in the eduction pipe the air has a tendency, on account of its lighter weight, to come to the surface faster than the water. This causes what is known as "slip," and is one of the principal reasons for the low efficiency of the air lift.

The air lift system is not adapted to pumping horizontally a great distance, and for this reason the horizontal discharge should always be kept as short as possible. When the reservoir is some distance from the wells it is better to discharge into a small elevated tank and then allow the water to flow to the reservoir by gravity.

RATIO OF AIR TO WATER VOLUME.

When 60 per cent. of the entire length of the water discharge pipe is submerged the following ratio of air to water should be observed:

For lifts not exceeding	Volumes of air to 1 of water.
25 ft.	2
50 ft.	3
75 ft.	4½
100 ft.	6
125 ft.	7½
150 ft.	9
175 ft.	10½
200 ft.	12

Thus to ascertain the volume of air required, quantity of water and lift being known. Divide the required quantity of water in gallons by 7½ in order to reduce it to cubic feet; then multiply the quotient by the figure from above tabulation, representing the volume of air required for the lift necessary to raise the water. Assume, for instance, that 200 gals. of water are to be raised to the surface in a minute and that the water level will fall 75 ft. below the surface when pumping. 200 ÷ 7½ = 26.5 × 4½ = 120 cu. ft. of free air required per minute.

REQUIRED AIR PRESSURE.

The required air pressure is determined by the head of water outside of the water discharge pipe from the level in the well to the bottom of the water and air pipes. Assume, for instance, that the water level in the well stands even with the surface of the ground when not pumping, but that when it is pumped the water level will drop 50 ft. below the surface of the ground. This would make it necessary to have the air and water discharge pipes 125 ft. long. When starting pumping it would, of course, be necessary to raise a column of water 125 ft. in height, and allowing 0.434 pressure for each foot lift the starting air pressure required would be $125 \times 0.434 = 54$ lbs. As it has been assumed that the water level will drop 50 ft. after the well is pumped, there would then be a head of water outside of the water discharge pipe 75 ft. in height with which the air would have to contend, making the running air pressure $75 \times 0.434 = 32.5$ lbs.

Still an easier method of obtaining the volumes of free air, pressure, submergence and indicated horsepower is given in Table I. For instance, say it is desired to raise 210 gals. of water per minute 50 ft. high. This will require 75 ft. submergence, 33 lbs. air pressure, 84 cu. ft. of free air per minute and the compressor must develop 7.5 I. H. P.

TABLE I.—RELATIVE LIFT, SUBMERGENCE, AIR VOLUME AND PRESSURE, AND I. H. P. OF COMPRESSOR.

Lift, ft.	Submergence required, ft.	Air pressure, lbs.	Cu. ft. free air per gal. per minute.	I. H. P. per gal. raised per min.
25	38	17	0.3	.0156
50	75	33	0.4	.036
75	113	49	0.6	.07
100	150	65	0.8	.0925
125	188	82	1.0	.16
150	225	98	1.2	.212
176	263	115	1.4	.265
200	300	130	1.6	.318

Under favorable conditions the air consumption in Table I may be reduced as much as 15 or 20 per cent.

Efficiencies as high as 33 per cent. have been obtained under favorable conditions when a fair-sized, first-class, two-stage compressor is used. This is the I. H. P. or the electric power at switchboard figured against the theoretical horsepower of water delivered.

Table II gives a list of the approximate size and capacity of side inlet devices for foot pieces now placed on the market by several companies and the size of wells they will go into.

TABLE II.—DATA ON SIDE INLET DEVICES.

Air pipe, ins.	Water pipe, ins.	Size well, ins.	Maximum capacity, gals. per min.
¾	1½	4	25
1	2	4½	50
1	2½	5	75
1¼	3	6	105
1½	3½	7	145
1½	4	8	190
2	6	10	425
2	5	9	300

Sometimes the size of the well does not permit the use of the side inlet piece; then the central air pipe system is used. If the well is cased far enough down to admit of 80 per cent. submergence, the well casing is used as the water discharge pipe and the air pipe is put down into it. About 2 ft. from the bottom of the air pipe a number of holes are drilled for the air to escape from. The size of the pipe depends a great deal upon the size of the well and the quantity required, but the following figures will give a general idea:

Well casing, ins.	Use air pipe, ins.	Capacity gals. per min.
3½	1¼	115
4	1½	150
5	2	240
6	2	360

In estimating the quantity of water that can be forced through a given size discharge with the best economy, the following rules should be observed:

25 ft. lifts 10 to 11 gals. to each square inch area of water pipe.

50 ft. lifts 12 to 13 gals. to each square inch area of water pipe.

All higher lifts 14 to 15 gals. to each square inch area of water pipe.

Usually this can be exceeded, but only at the expense of economy in air consumption. In pumping wells of 12 ins. or more in diameter, unless the well is crooked, the air lift does not give as good results as the deep well centrifugal pump that is now being placed on the market by several companies.

The data here given have been gathered during the past ten years by the author both from experience and observation. Some of the information has been obtained from water works superintendents and sales engineers who have had the opportunity of testing and watching the operations of this system of pumping. For general use the above figures have proven very satisfactory.

It is well to bear in mind, as pointed out in *Engineering and Contracting* of March 17, 1915, that the air lift should not be installed without the advice of an engineer who has made a special study of the subject, and only after he has been given an opportunity to make trials with various lengths of air pipe and various speeds of compressor operation after the lift has been installed. The latter consideration is important, as by successive adjustments of submergence and compressor speeds the most economical operating conditions may be found.—*Engineering and Contracting.*

HOW COMPRESSED AIR SAVED THE FLORISTON

BY ROBERT G. SKERRETT.

Shortly after the beginning of the war in Europe, the steamship *Floriston* sailed from Quebec under rush orders bound for England with a cargo of hulled gram. Officially, the ship has a gross tonnage of 3,429 tons and a net tonnage of 2,236 tons. However, owing to the exigencies of the hour, she was actually loaded with 4,000 tons of wheat, which put her down considerably deeper than her Plimsoll mark.

Just before clearing the Straits of Belle Isle on a dark night the ship hit an iceberg squarely bow-on when running at a speed of about 10 knots. She was so badly injured that her skipper ran her ashore upon the nearest point of the coast of Newfoundland. There for several days she pounded upon the rocky bottom and materially aggravated the damage forward. A small steamer, the *Wren,* came to the rescue of the *Floriston* and managed to pull her off and to tow her into Port Saunders—the nearest haven. The *Floriston* came to anchor in 13 fathoms of water, and at the time was drawing 31 feet forward and 22 feet 4 inches aft. After practically abandoning all hope of saving her, recourse was had to compressed air under the supervision of Mr. W. W. Wotherspoon of New York city, and the damaged craft was safely run under her own power some hundreds of miles to Quebec.

It was not until the *Floriston* reached Port Saunders that it was possible to examine her injuries. After the divers had made two surveys, it was found that the vessel's bow had been very badly crumpled up. The accompanying illustrations clearly indicate the extent. The upper and the lower forepeak were flooded, and so, too, were cargo space No. 1 and Nos. 1 and 2 ballast tanks, while ballast tank No. 3 was leaking, but could be kept under control by the ship's pumps.

The Canadian Salvage Company and the Quebec Wrecking Company took the ship in hand and started at once to make her ready for the application of compressed air—first removing about 800 tons of grain from the forward hold, where fermentation had started and the gasing was very noticeable. Immediately after the installation of the necessary air compressors, ballast tanks Nos. 1 and 2, and so much of the lower forepeak above the ruptured skin were placed under pressure and "blown," together with the upper forepeak, and in this way the vessel's bow was raised 4 feet, bringing her to the 26-foot waterline.

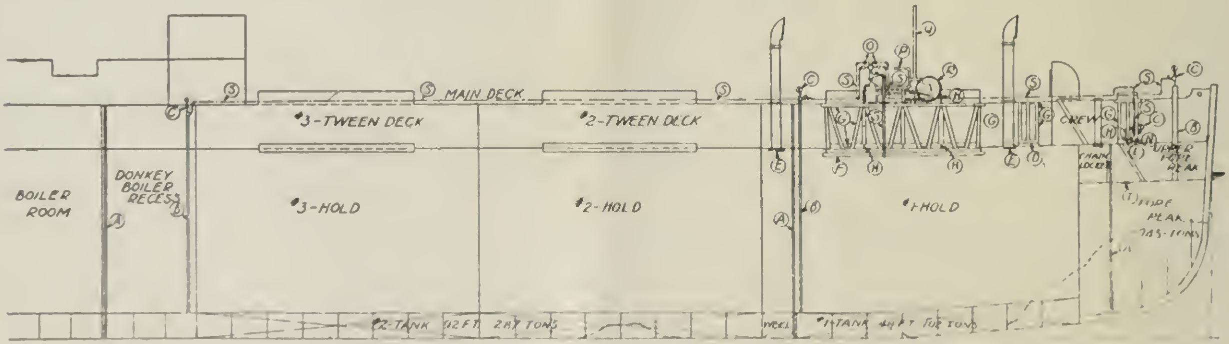
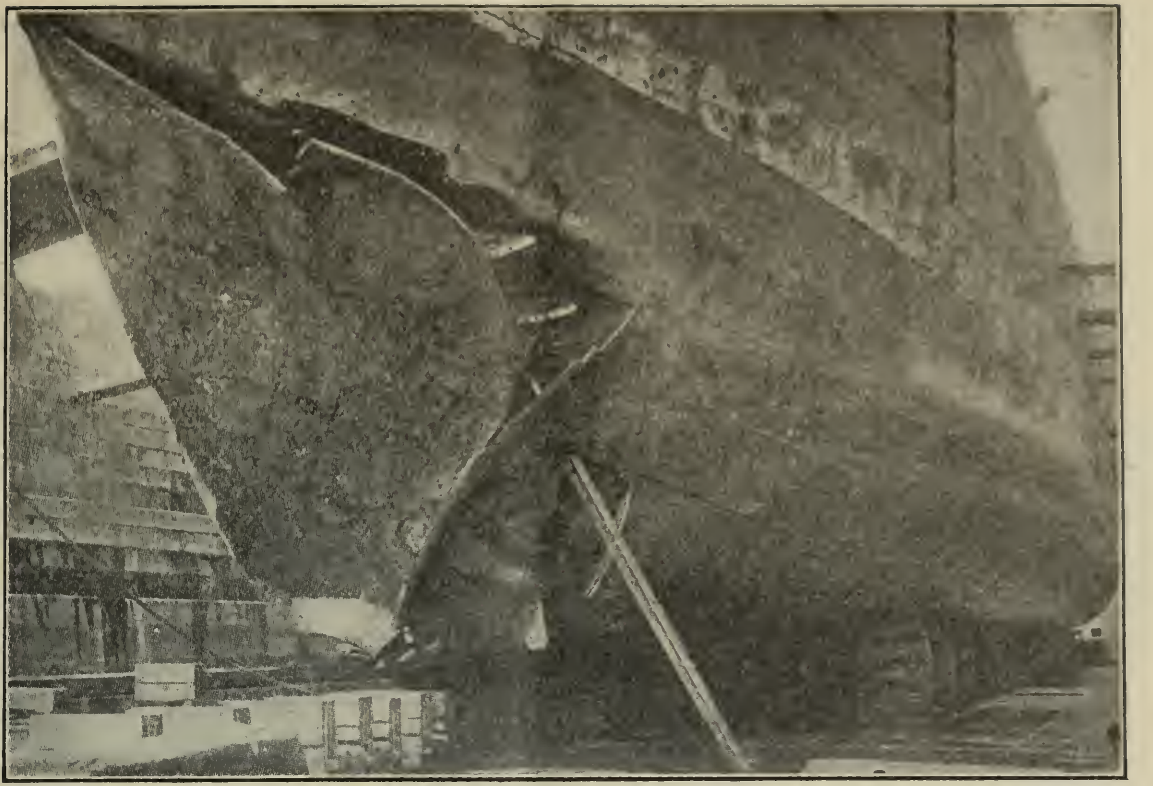


Fig. 1—*A*, Sounding Pipes Closed to Compartments Placed Under Pressure. *B*, Air Escapes Used for Connecting Pressure Sets to Compartments Placed Under Pressure. *C*, Pressure Sets. *D*, Closing Cover for Trimming Hatch *E*, Closing Covers for Ventilators *F*, Closing Hatch for No. 1 Hold. *G*, Shoring and Bracing for Hatch Covers. *H*, Strong-backs Bolted to Ship's Structure. *J*, Closing Covers for Hawse Pipes. *K*, Closing Hatch for Air-lock. *L*, Underhung Escape Hatch for Air-lock. *N*, Blow-off. *O*, Control Valves for Air Supply to Compartments. *P*, Steam Supply to Compressor. *Q*, Exhaust from Compressor. *R*, Air Compressor *S*, Air Supply Pipes to Compartments *T*, Manhole Access Forepeak

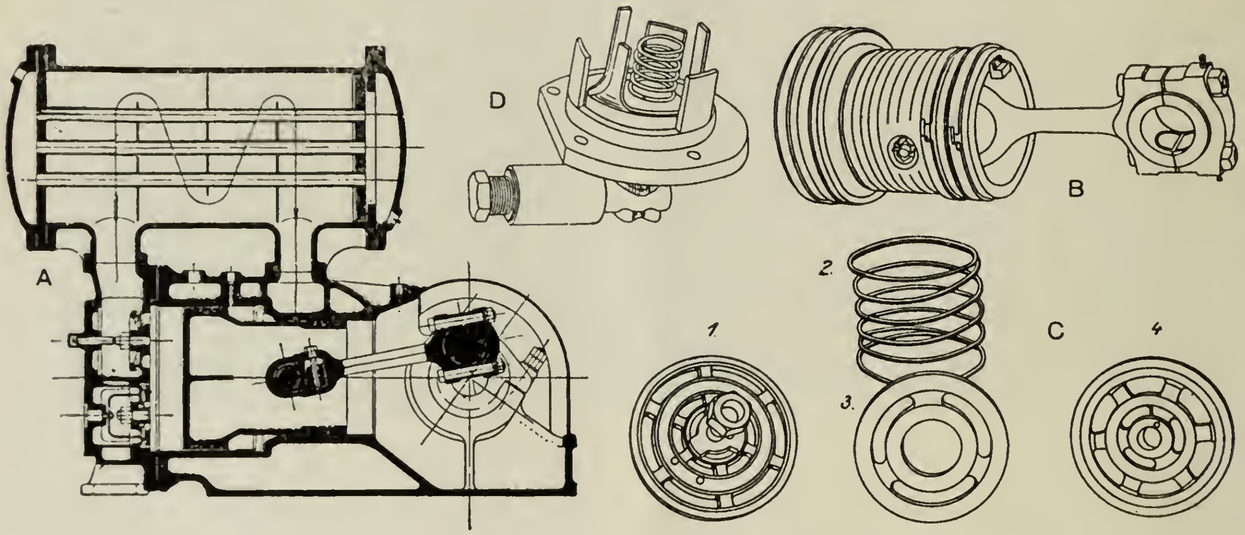


FLORISTON IN DRYDOCK.

In making the air connections, the existing air vents were used in the drained compartments for conduits, while certain other air vents were sealed. In this manner complete control of the various spaces was secured from a single operating station on the main deck. In accordance with the Wotherspoon system the flanking compartments or neighboring spaces were also put under pressure, in order to reduce the stresses upon the divisional bulkheads and the overlying decks. The large hatch leading into cargo space No. 1 was sealed by an airtight cover composed of two layers of planking with intervening sheets of tar paper. The hatch leading into the upper forepeak was similarly sealed, with the addition of an air-lock attachment by which admission into the forepeak could be secured when that space and the compartment below were under pressure. In order to support the deck immediately above the forepeak and the cargo space, shores were placed between it and the main deck just above. This was a very necessary provision, because the *Floriston* was inclined to "hump" as she forged ahead on her long trip to Quebec, and the intermittent stresses would probably have proved fatal but for the stiffening secured by binding the two decks together in this fashion.

The entire work of preparing the *Floriston* for her run from Port Saunders to Quebec was finished in the quick time of six days, thanks to the experience previously gained in handling some other vessels in the same manner, although not so far away from bases of repair. The nature of the steamer's cargo demanded rapid action, and compressed air was the very best medium with which to battle with the gases given off by fermentation while furnishing the needful support to the confining bulkheads and deck plating. The salvers were obliged to watch this subtle foe at every stage of the homeward journey and to adjust the air pressure in the surrounding compartments accordingly.

The accompanying diagram shows the manner in which the salvage installation was made, and it is doubtful that the vessel could have been saved by any other method, considering the cargo aboard and her remoteness from any place for repairs. It was quite out of the question to use cement on the job, and compressed air was logically the only rational solution under the circumstances. The gravity of the *Floriston's* wounds are quite manifest, but because her stem and forefoot were turned so far back and upward, the first diver reported rather moderate injuries—assuming merely the rupture of the bottom plating and judging the upturned stem to be the lower edge of the break. This long trip to a repair port emphasizes the potential advantages of a permanent compressed air self-salving installation aboard large ocean-going vessels. The initial cost is moderate, and ships so equipped would unquestionably be able to obtain better insurance rates and shippers and owners feel just that much more secure.—*International Marine Engineering.*



A SINGLE CYLINDER TWO-STAGE COMPRESSOR.

A SINGLE CYLINDER, TWO-STAGE, CRANK DRIVEN AIR COMPRESSOR

The cut here reproduced from the Journal of the American Society of Mechanical Engineers, shows the essential features of a new compressor built in Bavaria, Germany. Although a two-stage, single cylinder is not a novelty in itself, special claims as to compactness and rigid stability may be made for the present design.

The base of the machine rests on a prepared foundation for its entire length which is effective in eliminating vibration. The low pressure cylinder hood is also a valve chamber, containing both the inlet and the discharge valves for that end. After the preliminary compression the air passes through a large intercooler and then into the annular space where the second compression takes place. At C is shown the type of valve used, a ring valve with small lift.

As the compressor is assumed to be belt driven the intake of air is regulated by a separate unloading device D which is automatically regulated by the receiver pressure. In addition to this, further regulation is secured by an electromagnetic clutch by which the crank shaft is stopped or started while the wheel continues to run.

President Wilson has ordered the name of Culebra Cut to be changed to Gaillard Cut. This was done in honor of the late Colonel Gaillard who had charge of this most difficult part of the canal work.

WHAT IS ATMOSPHERIC HUMIDITY?

BY G. P. PEARCE.

While talking at an Engineer's Club, the conversation happened to turn on the subject of humidity. The majority were of the opinion that it was moisture absorbed by the air, something like a sponge absorbing water; some thought it was an actual chemical combination that took place between the air and water, as oxygen and carbon combine to form carbonic acid gas, and one was strongly of the opinion that it simply was minutely divided or atomized water mechanically suspended in the air. Not one of them knew just how to figure out the weight of a cubic foot of saturated air at a given temperature, or the weight of the contained moisture.

There is nothing mysterious about humidity except, perhaps, its name, which is derived from a Latin word meaning "to be moist." Humidity is simply a way of talking about a mixture of air and steam. Let us take a tank that holds just one cubic foot and pump out all the air. We will also assume that the temperature of the engine room where we will make this experiment is 90 deg. F., which will be the temperature of the tank. Now let us inject a little water into the tank, and of course we all know what will happen; enough of it quickly evaporates into steam until the space becomes saturated for the temperature of 90 deg. F. We will next draw out all the surplus water and now have a cubic foot of saturated steam at a temperature of 90 deg. F., and if we had carefully weighed the tank before and after, on very sensitive scales, we could discover the weight of the cubic foot of steam. But there is no need for us to go to all this trouble, as we can find it all from the steam tables in our engineer's handbooks; by looking up the new Marks & Davis steam tables, we find for a temperature of 90.1 deg. F., which is near enough for this experiment, that a cubic foot of steam at this temperature, weighs 0.002,137 lb., and that the pressure is 0.698 lb. per sq. in. absolute. So now we know all we want about a cubic foot of steam under these conditions.

We will next pump out this stream and then let the tank fill with dry air, which we can get by letting the air suck in through some calcium chloride; this will completely dry it. We now have a cubic foot of dry air at 90 deg. F., which will weigh 0.072,197 lb., as we can find from a table of air weights; or we could get it by very accurately weighing the tank. The pressure we will take as 14.7 lb. per sq. in.

Now, it is known that the space above a liquid will always become saturated with its vapor until a balance is established, whether the space at the beginning is a vacuum, or is filled with a gas; in other words, the presence of gas has no effect upon the amount of vapor formed. Take water, for instance; the weight and pressure of the vapor for saturated steam formed over the surface of the water will build up to the same amount whether there is any air present or not. It seems as if there is plenty of room for the steam molecules to be present in the air without in any way interfering with one another. Let us then take our tank containing one cubic foot of air and inject some water into it. This will evaporate according to the abovementioned law until the tank is filled with steam to the same weight and pressure as found when it was tested.

Starting from the vacuum this is 0.002,137 lb. at 0.698 lb. per sq. in. Taking out the unevaporated water we now have a cubic foot space with 0.002,137 lb. of steam and 0.072,197 lb. of air, a total weight of 0.074,334 lb., and the pressure inside will be 14.7 lb. absolute, due to the air and 0.698 lb. due to the steam, a total pressure of 15.398 lb. per sq. in. Next, we will open the valve and let enough of the mixture escape to reduce the pressure to atmospheric, or 14.7 lb. per sq. in. This we can easily figure, for it will be according to Boyle's law—

$$P_1V_1=P_2V_2$$

Thus 15.398 lb. multiplied by 1 equals $14.7\times X$,

$$\text{or } X=1\times 15.398\div 14.7=1.0475 \text{ cu. ft.}$$

and the weight of one cubic foot will be equal to

$$0.074{,}334\div 1.0475=0.070{,}95 \text{ lb.,}$$

which is the weight of one cubic foot of saturated air (100 per cent. humidity) at 90 deg. F.

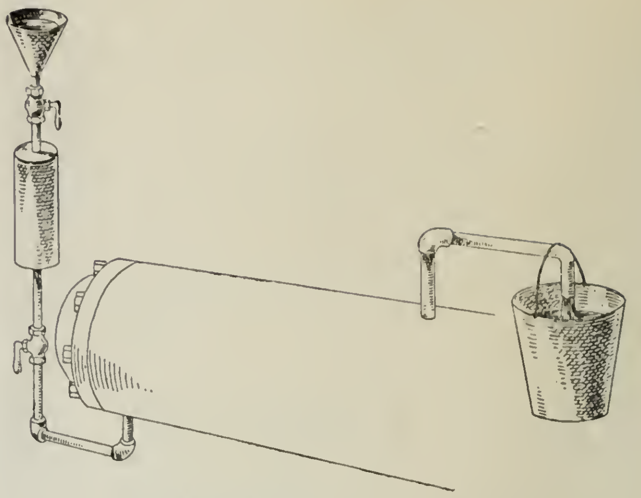
We will now find the weight of water in the cubic foot of saturated air, which is easy, because we know that the original cubic foot of steam weighs 0.002,137 lb., and that, due to its pressure combining with that of the air, it expanded to 1.0475 cu. ft. Therefore the weight of the water, or rather steam, in the cubic foot of saturated air is $0.002{,}137\div 1.0475=0.002{,}041$ lb., and the weight of the air of course is $0.070{,}95-0.002{,}041=0.068{,}909$ lb.—*Practical Engineer.*

PNEUMATIC TOOLS BOOST THE MONUMENT BUSINESS

The change that has come about in the monument business is tremendous. Many years ago when we first adopted our compressor plants for the retail monument dealer you would not find more than perhaps one man out of twenty-five that had any kind of equipment at all. This party would perhaps have a large shop where marble was cut out of rough and sometimes the plants were as big as 50 to 100 H. P. and employed from thirty to forty men. With the advent of pneumatic tools, making it possible to cut granite, we found a very quick change coming over the monument business. The old style shops gradually were pushed aside and we had quite a demand for power plants from 15 to 40 H. P. With the low price gasoline, and the ease of adapting them to the monument man's conditions we installed many of these outfits.

About seven years ago we had occasion to build several small plants for cemetery lettering. These outfits consisted of a plain 2 to 3 H. P. gasoline engine connected by means of belt to a small compressor and the entire outfit mounted on truck. These were made at the special request of some of the more progressive monument dealers. After putting out a few of these machines we noted that our customers were in the habit of using these machines for shop work, sometimes while their big plant was shut down for repairs or during the slack season. We suddenly realized that there would be a permanent demand for these smaller outfits and not only could these plants be used for cemetery work but it would be possible to have every retail monument dealer, no matter how small his shop might be, equipped with such a machine. Of course, there has always been a certain amount of prejudice to be overcome because we used gasoline on these early equipments. This fact forced us to make electric driven units as well. Though an electric outfit costs from three to five times as much to operate still they are entirely fool-proof. Where they are to be used for the shop only they have been successful. Of course, they cannot be used for cemetery work. Neither can they be used in districts where day current cannot be obtained.

Not only has this small pneumatic tool plant made it possible for the small dealers to compete in the character of their work with the better equipped larger shops but they have been able to get down in price, turn their work out quicker and in accordance with their promises. They have been able to get stock monuments during the dull season instead of trying to live twelve months off of the earnings of six months. At the same time the mere hum of pneumatic tools brought business to the doors of our customers. The mere fact that a man has a good set of tools to work with seems to fire him with a certain amount of ambition. He takes more pride in his work, he does things more thoroughly, it wakes him up to the possibilites that are floating all around him. We prophesy that the time is coming when a dealer in the monument business will either have to have some good, clean-cut way of getting his work out quicker and better, or he will be forced to quit the business.—*Henry N. Schamm, in Granite, Marble and Bronze.*



ARRANGEMENT FOR ACID WASH.

ACID CLEARS A WATER JACKET

The cooling water for the air cylinder jackets of a compressor 18¼ and 12¼ × 12 in., the water containing a large amount of sulphate of lime, had been throttled and made to flow so slowly that the water was abnormally heated so that it deposited inside the jacket a hard scale that we could not get at to remove with tools. I used muriatic acid piped to flow through the jacket as shown in the crude sketch herewith. To operate, close the lower valve and fill the reservoir with acid. The reservoir should be placed higher than shown to give a little head or pressure. Then open the valve and the acid will fill the jacket and overflow into the pail. It took ten gallons at 60 cents per gallon to do the job, using it over and over again as long as it had any strength. It worked fine, disintegrating the scale and clearing the jacket.—*W. A. Hendry, in Power.*

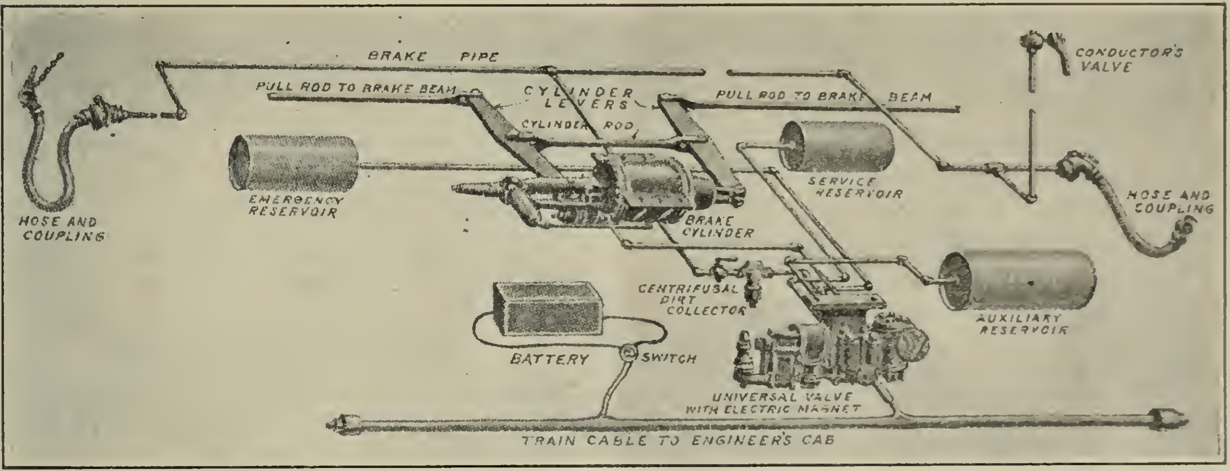
THE WESTINGHOUSE AUTOMATIC AIR BRAKE

BY HERBERT T. WADE.*

In the year 1890, with a train weight of 280 tons running at a speed of 60 miles per hour, the energy to be dissipated was about 33,000 foot-tons and the stopping distance with the application of the brakes was 1,000 feet. In the year 1913, with a train weight of 920 tons, running at this speed of 60 miles per hour, the energy dissipated was 111,000 foot-tons, almost four times greater than that of the train first mentioned. Now, if the second train was equipped with a brake of the same class as that of the former, the stopping distance would be 1,760 feet and its collision en-

*Abstract from Scientific American.

ergy when it passed the 1,000-foot mark where the first train would have stopped would still be 48,000 foot-tons, or one and one-half times as much as the 1890 train had when the brake was applied, with still 760 feet to run. With the latest improvement in the air brake such a train can now be equipped with the new brake apparatus so that it can be stopped in 860 feet, at which point with the old brake it would have been running at 43 miles per hour and with a collision energy of 57,000 foot-tons, or still about twice that contained in the train of 1890 at the beginning of the stop. In fact, the energy that must be dissipated by the air brake on a modern train with modern speeds of travel has increased eighty-fold since the original invention of the air brake.



LAYOUT OF AUTOMATIC AIR BRAKE.

The important advantages that now figure in the Pennsylvania equipment were secured by improvements both in the effectiveness of the brake as a whole, as well as in detail. By the brake is meant not only the triple valve fundamental to the Westinghouse air brake, but the entire mechanical organization and assembly of the various elements. Improvements were made in the efficiency of the braking system as a whole, and also in the automatic and manual control of the brake operated, this function, naturally, being rendered more difficult by the increasing lengths of trains. But before any such innovation could be made on a large scale it was necessary that it should receive a complete and thorough test under actual working conditions. This was done on the Pennsylvania Railroad, employing a train air brake many elements successively have of twelve steel passenger cars and a modern locomotive, weighing nearly 1,000 tons and about 1,000 feet in length.

The locomotive and cars are fitted with the new mechanism, which, in its most improved form, aside from the principle of operation concerned, involved also the use of two shoes per wheel as higher retarding forces could be developed than were possible with a shoe on only one side of the wheel, on account of the limits of excessive piston travel, of brake shoe wear and distortion producing variable results of unequalized strains in brake, and of journal troubles.

In the improvement and perfection of the been added until to-day the mechanism, while increasingly effective, is of considerable complexity. For example, with long trains with the older systems there would be delay in the application of brakes at the rear, and there would be unevenness and shock in stopping. Due to the delay incident in the mechanical operation of the system the stopping distance at high speeds and with heavy loads and long trains could not hitherto be reduced as was desired in the interest of safe and effective operation. The new system secures immediate action at each triple valve by substituting therefor a universal control valve, where not only are all the essential features of the air control included, but also there is incorporated an electric system whereby the braking mechanism at the rear end of a long train, or at any car, in fact, does not have to wait an appreciable amount of time for the difference in pressure to be realized, but the valves are opened or closed by local electro-magnets energized from a battery circuit in each car.

The electro-pneumatic equipment is arranged so that when operated eletcrically the service application of the brakes is actuated by a reduction in brake pipe pressure as when operated pneumatically. The electric effect is the same as the pneumatic effect and the electric valves operate the pneumatic valves in similar fashion, only the response is made immediately—the electro-magnetic valves responding more promptly. The release magnets are controlled by the brake valve handle in either release or holding position, and with an electro-pneumatic emergency application the emergency magnets on all cars simultaneously and instantaneously energize and open their respective emergency magnet valves, which, in turn, cause the quick action parts of each universal valve to operate and produce an emergency application of the brakes. If the hose bursts or a conductor's valve, familiarly seen in a passenger car, is opened, the first universal valve to be affected by the resulting drop in brake pipe pressure will operate pneumatically and close its emergency switch so that the emergency magnet circuit throughout the train is energized and an electric emergency application on all brakes obtained.

The new system, which at first examination is quite complicated, both by its arrangement of electric connections and the arrangement of valves and magnets, secures now the application of the air brakes more quickly, also giving increased emergency stopping power, and enables the use of a higher pressure which may be held without diminution toward the end of a stop, while at the same time a more efficient design and better installation of foundation brake rigging has been adopted so that both the application and release of the brakes is more positive and reliable in all its operations. The new system, as stated, employs two shoes per wheel, which is known as the "clasp brake," and it is arranged to operate so that the time of obtaining the maximum emergency brake cylinder pressure on the train as a whole, according to the official tests, was shortened from eight seconds with the best previous equipment to 3.3 seconds with the improved apparatus; and when the electric control, which was a further feature of the new system, was used, this could be diminished to 2.25 seconds. The electric system is controlled from the engineer's valve without extra levers or switches, the electrical mechanism being connected with the simple control valve, the circuits being arranged within. The system also works automatically in case of any failure along the line, and there results a simultaneous application of just as great retarding force with the elimination of all violent slack action and shock.

With the universal control a train of twelve steel cars and locomotive with the electro-pneumatic brake, 150 per cent. braking power, clasp brake rigging, unflanged brake shoes, can be stopped:

From 30 miles per hour in200 feet equivalent to an average retarding force of 300 pounds per ton.

From 60 miles per hour in 1,000 feet equivalent to an average retarding force of 240 pounds per ton.

From 80 miles per hour in 2,000 feet equivalent to an average retarding force of 214 pounds per ton.

It would seem, therefore, that here we have an important step forward toward increase of safety, and that increased speeds may be used with proper safety, while greater density of traffic can be permitted under good conditions of operating that will give increased returns.

AIR-LIFT NOMENCLATURE

Standard terms used in air-lift pumping are as follows: (1) Static head: normal water-level when not pumping, measured from surface or top of well casing. (2) Drop: point to which the water-level drops below the static head while being pumped. (3) Pumping head: level of water when pumping as compared to ground surface or top of well-casing. Static head + drop = pumping head. (4) Elevation: point above the ground surface or top of well-casing to which water is raised. (5) Total lift: distance water is elevated, from level when pumping, to point of discharge, at an elevation, and includes: elevation + static head + drop = total lift. (6) Lift: distance the water is elevated from level when pumping to point of discharge at surface, and includes: static head + drop = lift (or pumping head). (7) Submergence: distance below the pumping head at which the air is discharged into the water. (8) 100 per cent.: the vertical distance the air travels with the water from point introduced to point discharged, and includes: total lift or lift + submergence = 100 per cent. (9) Starting submergence: distance below static head at which the air picks up the water.

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THE EXPLOSIVE AGE

Why should not the present be called the age of explosives, or, perhaps still better, the explosive age? There would seem to be no other characterization so applicable. The present world wide war, for instance, which is the all engrossing fact of the time, came upon us with the suddenness and the destructive force of a terrific explosion, and in the successive war operations in detail explosives are all in all. There is practically no more face to face cutting and thrusting. The sword is obsolete, even the bayonet is obsolescent, and the spectacular battle-axe is forgotten, so that when the time shall come for the war to cease it is not easy to see how the swords and the spears shall be turned into plowshares and pruning hooks, since the ancient weapons of war are now conspicuous by their absence from the bloody field, and it would be absurd to try to continue their vogue.

It is a war of projectiles, and not satisfied with the initial explosion by which the projectile is sent on its long flight for destruction, it is now normal practice to have a supplementary explosion after the shot is thrown, and so all the contestants are crying for shrapnel. Then, too, the horse for the transportation of munitions and supplies is superseded by the explosive driven motor wagon, and explosives, too, are the one essential element of the Zeppelin, the aeroplane and the submarine. How suddenly modern wars would end if explosives ceased to explode.

However, there is nothing essentially devilish in explosives as such. They are quite as ready to work, and will work quite as efficiently in the interests of peace as of war. Not only are the dynamites and explosives of the fiercer type our most efficient agents in the mining of our mineral wealth, but what we may call the milder explosives are coming to be our most economical sources of power in all the industries.

Soon will be coming along the season of county and state agricultural fairs; and in the exhibits there to be seen, nothing perhaps is more striking than the completeness with which the explosive engine, the gasoline motor, has superseded the steam engine. The Humphrey pump and the Deisel engine are beginning to show the applicability of the explosive motor to the largest power units, and the latter is directly indebted to Compressed Air for its success.

HEATING VALUE OF COMPRESSOR JACKET WATER

Can a mixture of air and water be compressed in a cylinder so the heat of compression will convert the water into steam, the water entering the cylinder in the form of spray or vapor and at a temperature of 200 deg., the air being at the same temperature? If this can be done, what are the conditions necessary to bring about this operation?

D. F.

A. Although in the act of compression the temperature of air rises high, the actual heat units represented are very few and would have no practical vaporizing effect upon even small quantities of water. Water jacketing is necessary for air compressor cylinders to keep their temperature down; but it is surprising to note how slowly the water is warmed—it would be scarcely proper to say heated. At the high speeds at which compressors are now ordinarily run, compressing by single-stage up to say 60 lb., or by 2-stage to 100 lb., the temperature of the jacket water, when flowing quite leisurely through, hardly rises above blood heat.

It is a curious fact that a proposition just the reverse of this has been a standing challenge to engineers for more than half a century. The "Cloud" engine, and many other contrivances, have proposed to get a cheap accession of power by injecting a considerable charge of air into a steam cylinder at each stroke and then letting the heat of the steam increase the volume and the power value of the air. Something may be said for this as to its theoretical feasibility, but nothing of practical and permanent value has ever developed from it.—*Frank Richards in Practical Engineer.*

NEW BOOKS

The Model T Ford Car, its Construction, Operation and Repairs. By Victor W. Page, Norman W. Henley Publishing Company, New York. 288 pages, 7½ by 5 inches, nearly 100 illustrations. Price, $1.

When it is understood that there are considerably more than half a million Ford cars in service, the field of usefulness for such a book as this must be immense. It is written by an expert and treats the subject in a thorough and exhaustive way. Much of the information and instruction embodied should be course be serviceable to operators of other machines, although no such claim is made.

Measurement of Gases where Density Changes, compiled by Henry P. Westcott, Metric Metal Works, Erie, Pa. 60 pages, 7¾ by 3¾ inches. Price, 50 cents.

The book consists entirely (after a preliminary explanation) of tables of multipliers to be used in connection with meter readings of the flow of natural gas at different pressures. There are twelve tables covering pressures ranging from a vacuum of 25 inches of mercury to 3 lb. above atmosphere.

AUTOMATIC AIR-PILLOW INSTRUCTION

The bathing beach proved attractive to the children and while they possessed the ambition to learn to swim they were also possessed by a fear of the water. The knowledge that the human body is not much, if any, heavier than water when the lungs are normally inflated with air did not seem to inspire sufficient confidence to lead them to make the plunge. Finally an air pillow was procured, properly inflated and adjusted to one of the girls, and with the confidence thus inspired a successful effort was made at swimming. Unbeknown to the swimmer a pin hole was made in the air pillow and the air soon escaped but confidence took the place of the air. The weight of imaginary fear was being carried by an imaginary air pillow and utterly unconscious of the true situation that girl was experiencing the thrills of a new sensation and when her attention was called to the fact that there was no longer any air in the pillow it did not take her long to make up her mind that she could swim without its aid. We all need air pillows at times in our lives to help us over unknown paths and the community needs air pillows to help it solve the road problems confronting it.—*From a speech by I. B. Clarkson, as reported in The Road Maker.*

The United States is now producing more than two-thirds of the world's petroleum, and there is a likelihood that the proportion will be increased. The country's oil production is valued at one-third that of all the metals mined.

ECONOMY OF COLD INTAKE AIR FOR COMPRESSORS

BY R. S. BAYARD.

It has often been observed that the output of an air compressor is greater in winter than in summer; that is, it seems that a machine which has had to "hustle" to furnish air in summer, may be able to maintain the required pressure at a reduced speed during the winter. The reason for this is often asked, so an explanation will be of interest.

This difference can be observed only when the compressor takes its air through a duct leading from the outside air, because it is due to the effect of the difference of air temperature between the compressor intake and the place where the air is used or conveyed through.

Imagine a cylinder having a perfectly tight piston held, we will say at midstroke, and the half-cylinder full of air at atmospheric pressure and at a temperature of 60 deg. F. The atmospheric pressure is, with 30-in. barometer, 100 deg. F. This 14.7 lb. per sq. in. With the piston held rigidly and leak-tight, assume that we can heat the cylinder so that the air inside will become 100 deg. F. This will cause the air to expand and try to occupy more space, but if the piston will not move the air cannot expand, so it will increase in pressure. Mathematically, the pressure produced in this way will be

$$14.7 \times \frac{100 + 460}{60 + 460} = 14.7 \times \frac{560}{520} = 15.84 \textit{ lb.}$$

That is, the new pressure, absolute, will be equal to the first pressure, absolute, multiplied by the ratio of the absolute temperatures. (The absolute temperature is found by adding 460 to the Fahrenheit temperature, as done above).

If in the cylinder we are considering, the piston is allowed to move as the air expands, and if it has no friction, so that the air pressure does not increase, the final volume will be larger than the original volume in the ratio of the absolute temperatures. If the original volume was, say 10 cu. ft., the final volume after the piston has moved due to the increase of air temperature will be:

$$10 \times \frac{100 + 460}{60 + 460} = 10 \times \frac{560}{520} = 10.77$$

At the usual room temperature (about 60 deg., or 520 absolute) the increase of volume is, roughly, 1 per cent. for every 5 deg. F. increase of temperature.

Let us see how the foregoing applies to a compressor plant. Irrespective of the outside temperature, the air in the shop pipe lines will be nearly at the temperature of the room by the time it reaches the tool. Suppose that in winter this temperature averages 68 deg. F., and that the air finally reaches the tool at this temperature. If the compressor takes in 1,000 cu. ft. of free air (air at atmospheric temperature and pressure) directly from the room, it will also deliver 1,000 cu ft. of free air at the tool, because the final temperature is the same as that at which it entered the compressor.

In summer the same conditions apply as long as the compressor takes its air from the same room in which the compressed air is used; but if the compressor is provided with an intake duct leading from the outside air the results will be quite different. First, consider the winter condition. Suppose the shop temperature averages 68 deg., and the outside air 30 deg. F. If the air is used at 68 deg. its volume will be considerably larger than the volume taken into the compressor from the outside air at 30 deg. If it requires 1,000 cu. ft. of free air per minute at shop temperature to run the tools, the compressor will have to take in only

$$1000 \times \frac{30 + 460}{68 + 460} = 1000 + \frac{490}{528} = 929$$

which is a saving of over 7 per cent. in air capacity, speed and horsepower. In summer, when the outside temperature is practically the same as the temperature indoors, there would be no saving by using the intake duct, except, as is often the case, when the compressor takes its air supply directly from the hot engine room. Thus, it is seen that the compressor would run at a speed about 7 per cent. lower in winter than in summer. The colder the climate, the more pronounced this effect would become.

An actual case where the application of an intake duct to a compressor represented an appreciable saving recently came to the writer's attention. An air compressor furnishing an average of 2,500 cu. ft. of free air per minute to a machine shop took its supply from the basement of the engine room, where all the year round the air, heated by a network of steam pipes, averaged 95 deg. F., while the shop averaged 70 deg. F. During the winter months the outside air averaged 32 deg. F., and in summer 70 deg.

Based upon the average consumption of 2,500 cu. ft. per min. for 10 hr. a day, the air used amounted to an average of

$$2500 \times 60 \times 10 = 1{,}500{,}000 \textit{ cu. ft.}$$

per day at the shop end.

As the compressor-intake temperature averaged 95 deg. F., the compressor was obliged to run fast enough to take in

$$1.500.000 \times \frac{95+460}{70+460} = 1.500.000 \times \frac{555}{530}$$
$$= 1{,}570{,}500 \textit{ cu. ft.}$$

of engine-room air per day.

The cost of compressed air in this plant was found to be 2.8c. per 1,000 cu. ft. of free air at the compressor. Thus the cost of furnishing air to the shop was

$$\frac{1{,}570{,}500}{1000} \times 0.028 = \$43.97 \textit{ per day}$$

By putting in an intake duct and furnishing air to the compressor at 30 deg. F. in winter, the compressor could have run slower and would have had to take in only

$$1{,}500{,}000 \times \frac{30+460}{70+460} = 1{,}500{,}000 \times \frac{490}{530}$$
$$= 1{,}387{,}000 \textit{ cu. ft. per day}$$

At a cost of 2.8c. per 1,000 cu. ft. at the compressor intake, the average cost of air for the plant during winter would then be

$$\frac{1{,}387{,}000}{1000} \times 0.028 = \$38.84 \textit{ per day}$$

During the summer, when the outside and inside temperatures both averaged 70 deg. F., the compressor would take in only the amount used in the shop, or 1,500,000 cu. ft., which at the cost of 2.8c. per 1,000 cu. ft. at compressor intake would be

$$\frac{1{,}500{,}000}{1000} \times 0.028 = \$42 \textit{ per day}$$

With the intake duct in use we then have a daily cost for air of $38.84 for winter and $42 for summer. The average for the year may then be taken at $40.42 per day, as against $43.96 with the compressor taking air from the engine-room basement.

During a working year of 300 days, the annual cost for air would then compare:

Without intake duct....$43.96 × 300 = $13,188
With intake duct....... 40.42 × 300 = 12,126

Giving a net saving with the duct of. $1,062

Capitalized at 10 per cent., this would justify installing an intake duct costing $10,620. As this figure approaches more nearly the cost of the compressor than it does the cost of the duct, the conclusion is obvious.

Incidentally, the saving of $1,062 per year amounts to more than 8 per cent. of the yearly cost for air. It certainly looks worth while to install an air-intake duct under such conditions.—*Power.*

EXPLOSION-PROOF ELECTRIC MOTORS

Among its investigations dealing with the means of lessening such dangers as attend the use of electricity in the mining industries, the Bureau of Mines has undertaken one that has for its purpose the establishment of permissible explosion-proof motors for use in places where an electric spark or flash might ignite inflammable gases or dusts.

Technical Paper 101, "Permissible Explosion-Proof Electric Motors for Mines; Conditions and Requirements for Tests and Approval," which has just been issued, mentions the details of construction that the bureau considers essential for satisfactory service and describes tests of an explosion-proof mining-machine motor and accessories approved by the bureau. The author of this paper is H. H. Clark, electrical engineer.

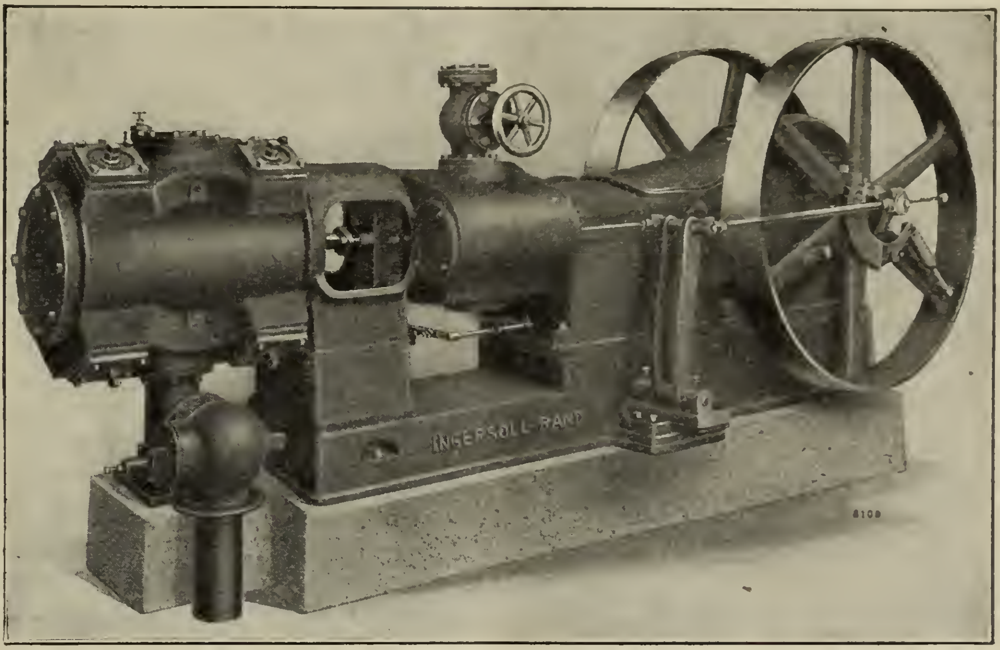
The Bureau of Mines has applied the term "Explosion proof" to motors constructed so as to prevent the ignition of gas surrounding the motor by any sparks, flashes, or explosions of gas or of gas and coal dust that may occur within the motor casing.

Before it undertook to establish a list of permissible motors the bureau made a large number of preliminary tests. No motors were approved as a result of this preliminary investigation, for none of the motors tested was considered to possess the characteristics of permissibility. As a direct result of these preliminary tests, however, the bureau decided to make tests to establish a list of permissible explosion-proof motors, and issued its Schedule 2, "Fees for Testing Explosion-Proof Motors." This schedule gave the general conditions under which motors could be submitted for test and the fees to be charged for making such tests. Technical Paper 101 sets forth more fully than Schedule 2, the details that the bureau considers essential to satisfactory explosion-proof motor construction.

The paper gives the requirements for approval of motors, outlines the nature of the approval of the bureau and describes the approval of an explosion-proof coal-cutting equipment.

ler" line. They present high speeds, give high compression efficiency, are almost silent in operation and require no operating mechanism.

Before adopting the "Ingersoll-Rogler" Valve a thorough test was conducted to determine the life of this type of valve. This test consisted in running a 12" stroke compressor at 400 revolutions per minute continuously over a period of one year, during which time no valves were broken nor any adjustments required, and in the two years since that in which this type of valve has been on the market practically no breakage has resulted.



AN UP-TO-DATE AIR COMPRESSOR.

A SMALL AIR COMPRESSOR OF HIGH EFFICIENCY

The constant demand for higher efficiency and greater economy, and the increasing tendency towards the use of higher steam pressures, has led to the development by the Ingersoll-Rand Company of the small steam driven high speed air compressor illustrated above.

This machine is designed along the same lines as the company's former small steam driven type, but embodies many improvements which give it a higher efficiency in the air end and a considerably lower steam consumption.

These improvements are:

"Ingersoll-Rogler" Air Valves. These valves are now standard on the company's extensive line of steam, power and electric driven compressors known as the "Ingersoll-Rogler" line.

Balanced Piston Steam Valves. This type of steam valve also was adopted after extensive research. It is designed after the most successful European practice, permits of higher speeds, high steam pressures and the use of superheated steam, at the same time giving a higher efficiency under ordinary low pressure steam conditions.

Automatic Cut-off Control. Giving the highest possible steam economy under conditions of varying load or varying steam pressures. This control is regulated by a centrifugal fly wheel governor which operates to shorten or lengthen the stroke of the piston valve, thus changing the cut-off.

Automatic Splash Lubrication, by means of which all wearing parts are copiously and continuously oiled.

Enclosed Construction and Removable Covers, make for cleanliness with great accessibility.

The automatic cut-off control is supplemented by an air unloader, assuring great economy while possessing a high degree of automatism, which is essential in a small compressor designed for severe duty, and generally subject to considerable neglect.

NOTES

California has 110 reservoirs for hydroelectric purposes, with storage capacity of 235,780,000,000 gallons.

Current at a pressure of 150,000 volts is carried on some western transmission lines.

Magnesium is used in the manufacture of sound copper castings because of its ability to decompose the gases formed by the copper in melting. The principal gas thus formed, carbon monoxide, is attacked by the magnesium, forming the two solids, carbon and magnesium oxide. By the use of magnesium, therefore, in small amounts, the production of blowholes in the casting is eliminated.

Popular Mechanics states—without any when or where, as is its practice—that a live gold fish was placed in a tumbler of liquid air, where of course it was instantly frozen solid, and that afterwards it was placed in a glass of water when "after a few seconds the fish showed indications of life and shortly commenced swimming around as lively as if nothing had happened."

With sixty million barrels of crude petroleum "above-ground"—stocks-on-hand, California oil producers offer a guarantee to manufacturers, hotel proprietors and steamship owners that they need have no fear of an oil shortage, but can install oil-burners at once. In addition, many wells in the State are "capped," awaiting better market conditions before being again added to the list of producers.

The third annual joint field meet of the U. S. Bureau of Mines, the American Mine Safety Association and the California Metal Producer's Association will be held at the Panama-Pacific Exposition, September 23 and 24. It is expected there will be a large attendance of mining men, as the joint meet will precede or follow the annual meetings of a number of institutions allied to the mining interests.

Recent tests show that the average candlepower hours obtainable from tallow or wax candles for one cent are 2.68. With a good tungsten filament lamp 120 candle power hours may be procured for the same sum, and with a gas filled tungsten 192.3 candle power hours are assured.

The discovery of oxygen is generally credited to Dr. Joseph Priestly, an English clergyman and scientist. The date, August 1, 1774, is commemorated as the birthday of modern chemistry. At about the same time two others made the same discovery: Scheel, a Swedish apothecary, who called it "fire air;" and Lavoisier, a French chemist, who called it oxygen, meaning "acid former." To Lavoisier is due the credit for the true explanation of combustion.

Under the trade name "Flexoid," heavy coated canvas tubing is being put out by the Bemis Bros.' Bag Co., of St. Louis, for carrying air into tunnels and shafts or taking off fumes, etc. It is put up in 10- to 24-in. diameters and 100- to 500-ft. sections; a man can carry 100-ft. on his shoulder. The canvas from which these tubes are made appears to be rendered air-tight and waterproof by a rubber coating applied to one side and forced partly through the fabric.

Electric consumers in Pasadena, Calif., had to pay 15c. maximum per kw.-hr. up to 1908, when the city erected its own plant. The private company began its fight against the city by a reduction to 12½c. The city began operations with an 8c. rate; the private company met it. In 1910 the city made its lighting price 5c. maximum with a wholesale rate of 3c. and a power schedule of from 4c. to less than 1c. It is estimated that the saving to the city has been $100,000 per year since the plant was established.

There are nearly a hundred thousand employes in the collieries of the anthracite coal fields of Pennsylvania who *mine no coal*. The exact number in 1913, the latest figures available, was 96,991. The men who mine and load the coal are the miners with State certificates and the miners' laborers. There were 44,346 miners in 1913 and 33,973 miners' laborers. Thus the army of men who are employed at ventilation, transportation, drainage, maintenance, and the preparation of the coal for market outnumbers by over 18,000 the men who are actually mining and loading coal.

Sand imported from Europe is being used in construction of the new subways in New York City. This is not because suitable sand cannot be obtained in this country, but because the war in Europe has cut down the cargoes which steamships ordinarily bring to such an extent that it is necessary for many to come over in ballast. They have been using beach sand as ballast. Upon arriving in New York this ballast is discharged and is practically given away to anyone who will haul it away. Rodgers & Hagerty, Inc., have used ten scowloads of this sand in back-filling what remains of the subway excavation.

An instrument for measuring the quantity of impurity in the air of a room or shop is the result of the inventive ingenuity of a German scientist. It consists of a glass bulb containing a red liquid which turns white on contact with carbonic acid gas. The liquid in the bulb is kept from the air; but once in every one hundred seconds a drop, drawn automatically from the bulb through a bent tube, falls upon the lower end of a stretched cord and begins slowly to descend the cord. If the air be foul with carbonic acid, the drop turns white at the upper end of the cord, and the purer the air the farther the drop descends before changing color. Alongside the cord runs a scale, like that of a thermometer or barometer, indicating the degrees of impurity of the atmosphere.

Henry Gardner studied mining engineering at Freiberg and later at Columbia. Soon after the outbreak of the war he enlisted in the British army, and went to the front. It is told of him that after serving as a private in the trenches for about six months, some sapping plans were inaugurated at the point where he was. Therein his mining experience played a useful part, of course, and attracted the attetnion of his superiors, who obtained the idea that such knowledge could be employed better than in the ranks. Consequently young Gardner was sent home for a little training in military engineering, after which he was returned to the front with a commission.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 4.

1,137,751. VACUUM-PUMP. Wolfgang Gaede, Freiburg, Germany.

1,138,083. ROTARY FAN. Willis H. Carrier, Buffalo, N. Y.

1,138,109. AUTOMATIC DEVICE FOR CONTROLLING THE SPEED OF TRAINS. Lawrence Wesley Horne and Warren Noble Crane, New York, N. Y.

1,138,110. GLASS-MELTING TANK-FURNACE. George E. Howard, Butler, Pa.

1. In apparatus of the class described, the combination of a glass melting tank, having a discharge opening, a hood, there being means of communication between said hood and the main supply of glass in said tank, means for opposing return flow of the glass through said communicating means, and means for varying the fluid pressure in said hood, whereby the level of glass therein may be raised above the normal level and means for thereafter depressing the level within the hood to cause a discharge of the glass from said tank through said discharge opening.

1,138,125. FLUID-EJECTOR. Maurice Leblanc, Auteuil, Paris, France.

1. An ejector device for compressible fluids, comprising an admission nozzle for motive fluid, a mixing cone receiving fluid from said nozzle and having a lateral discharge aperature formed therein at a point intermediate its ends for discharging excess fluid during the operation of starting the device, and a divergent nozzle communicating with the outlet of said mixing cone; the outlet of said discharge passage communicating with the region into which said diffuser discharges.

1,138,165. CRUDE-OIL BURNER. Charles Wirth, Scranton, Pa.

1,138,179. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,138,193. AIR-BRAKE SYSTEM. Patrick Coerford, Victoria, British Columbia, Canada.

1,138,199. REGULATOR FOR FLUID-COMPRESSORS. William Macfarland Donaldson, New York, N. Y.

1,138,202. APPARATUS FOR PURIFYING WATER BY MEANS OF OZONIZED AIR. George Erlwein, Berlin, and Christoph Knips, Charlottenburg, Germany.

1,138,206. PNEUMATIC-DESPATCH-TUBE-APPARATUS. Edmond A. Fordyce, Boston, Mass.

1,138,209. PERCUSSIVE TOOL. Arthur H. Gibson, Easton, Pa.

1,138,214. ATTACHMENT FOR ROCK-DRILLS FOR SUPPLYING WATER THERETO. Charles Hansen, Johannesburg, Transvaal, South Africa.

1,138,215. AIR-COMPRESSOR. Havelock Harford, Port Alberni, British Columbia, Canada.

1,138,248. DEVICE FOR AERATING LIQUIDS. Harry Vaughan Rudston Read, London, England.

1,138,266. PROCESS OF TREATING HYDROCARBON OILS. Charles H. Washburn, St. Louis, Mo.

1. The process of treating kerosene and heavier products of petroleum, which consists in

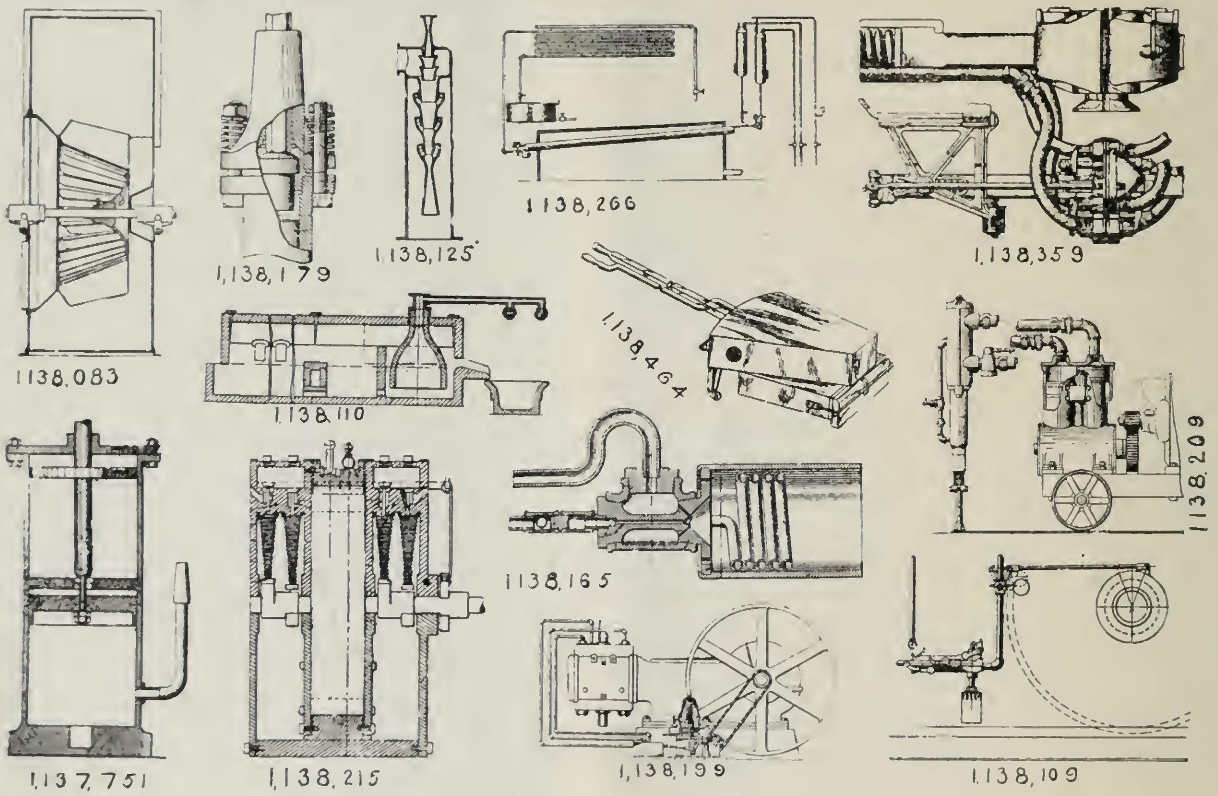
placing the petroleum product and water into a retort, converting them into vapor, and leading off the vapor to a condenser, the terminal of which is closed to create a back pressure against the vapor, thereby condensing the vapor under a pressure of from three to five atmospheres maintained in both the retort and the condenser.

1,138,278. PRESSURE-CONTROLLED VALVE. John H. Castle and William G. Rogers, Painted Post, N. Y.

1,138,359. AUTOMATIC TRAIN-PIPE COUPLING. Votaw S. Durbin, St. Louis, Mo.

1,138,380. PROCESS OF PRODUCING SOLUBLE MILK-POWDER. Gordon Don Harris and James S. Pollard, Bayonne, N. J.

1. The process of dehydrating or desiccating milk which consists in spraying the milk while at a temperature of substantially 98° Fahrenheit into the warm dehydrated air having a temperature of substantially 98° Fahrenheit, and then continuing the dehydration of the milk by subjecting the sprayed milk to warm dehydrated air having a temperature of substantially 98° Fahrenheit.



Pneumatic Patents May 4.

1,138,464. PUMPING MECHANISM FOR VACUUM-CLEANERS. Howard Eckel, Los Angeles, Cal.

1,138,612. ROCK-DRILL. Moses Arthur Knapp, Oakland, Cal.

MAY 11.

1,138,617. PUMP FOR VACUUM CLEANING SYSTEMS. George B. Bartley, Detroit, Mich.

1,138,749. BALL INFLATOR AND SEALER. Allen Ayrault Green, Galesburg, Ill.

1. In a device of the character described, an air-tube, a spring-actuated air-inlet valve associated therewith, an air-pump in communication with said valve, a cement nozzle having its outlet adjacent that of the air-tube, and a cement-injector for forcing cement through said nozzle.

1,138,801. HORN-BLOWING ATTACHMENT FOR AUTOMOBILES. William W. Scott, Plant City, Fla.

1. In an automatic signaling device, a frame, means for removably attaching said frame to the axle of a vehicle, a tube removably carried by said frame and means carried by said tube and designed to be automatically actuated by the wheel attached to said axle to operate a signal when the vehicle is rounding the curve.

1,138,806. PNEUMATIC WASHING APPLIANCE. Marcus L. Smith, Scranton, Pa.

1,138,849. INDIVIDUAL PNEUMATIC-ACTION MECHANISM. William F. Deitemeier, San Francisco, Cal.

1,138,877. PNEUMATIC HAMMER. Delphis T. Lelois, Chicago, Ill.

1,138,886. VARIABLE-CAPACITY COMPRESSED-AIR ENGINE. Bruno V. Nordberg, Milwaukee, Wis.

3. In a variable capacity compressed air engine adapted to be converted from a motor into a compressor at will and provided with means for varying its capacity as a compressor from zero to full capacity, the combination with a cylinder having a by-pass, of a valve normally closing said by-pass, means actuated by the engine for opening said valve at the limits of the piston stroke, and means for rendering said valve at the limits of the piston stroke, and means for rendering said valve opening means operative when the engine has reached its full capacity working under normal conditions as a compressor, to increase the work of compression.

1,138,893. STEAM VACUUM-PUMP. John G. Robinson, Melrose, Mass.

1,138,969. FLUID-PRESSURE MOTOR. Charles J. Olson, Muskegon, Mich.

1,139,066. PNEUMATIC TIME-SWITCH. George H. Parsons, Stamford, Conn.

1,139,084. VACUUM RENOVATING APPARATUS. Joseph H. Templin, Philadelphia, Pa.

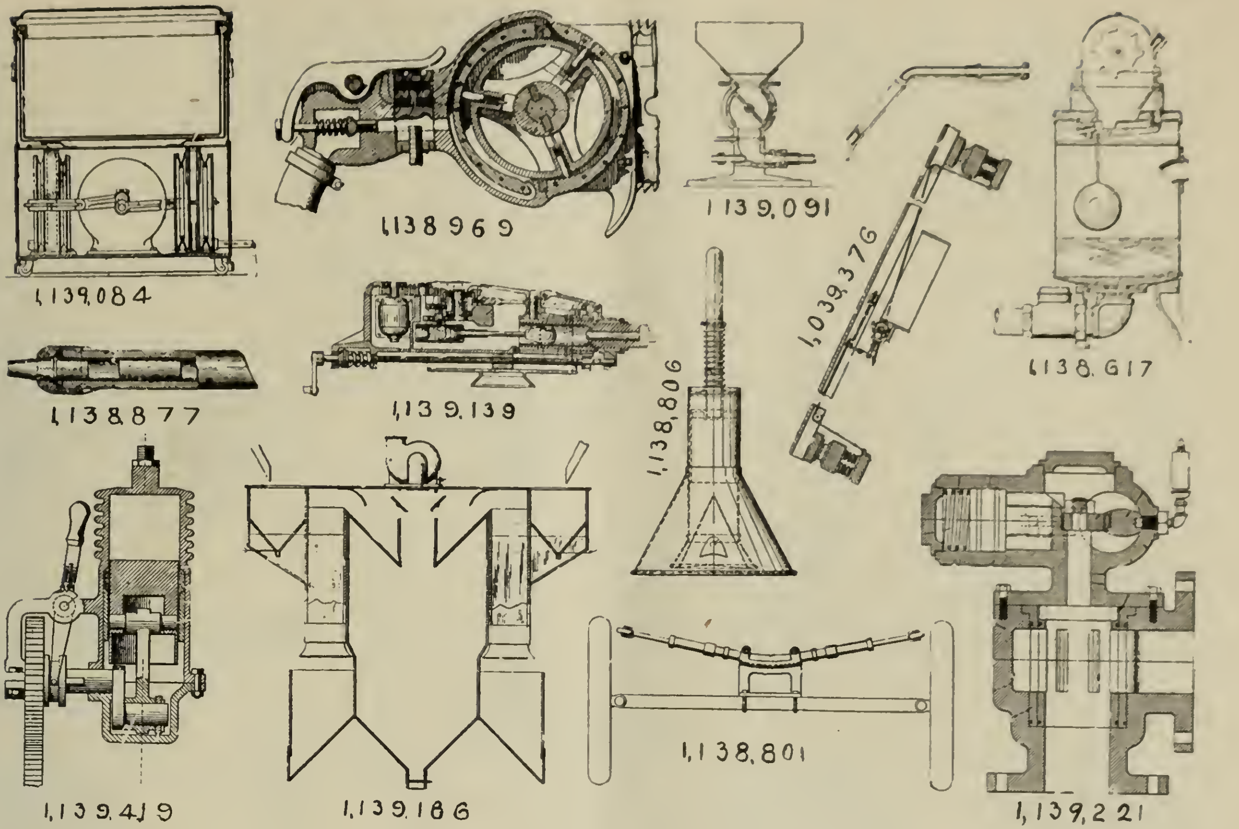
1,139,091. METHOD OF PLASTERING WALL-SURFACES. Carl Weber, Chicago, Ill.

1,139,139. ROCK-DRILL. William L. Smith, Chicago, Ill.

1,139,186. PNEUMATIC CONCENTRATOR. Reno D. O. Johnston, Nazareth, Pa.

1,139,221. STOP-VALVE. William G. Potter, Marblehead, Mass.

1. A stop valve embodying a casing having an inlet and an outlet passage and a rotary member in said casing adapted to alternately



PNEUMATIC PATENTS MAY 11.

open and close said passages when rotated in either direction, mechanism adapted to rotate said rotary member in opposite directions including a reciprocatory piston and a fluid pressure cylinder in which said piston is adapted to reciprocate, independent sources of fluid pressure connected to said cylinder at opposite ends of said cylinder, respectively, and fluid pressure operated means adapted to lock said piston in a predetermined position.

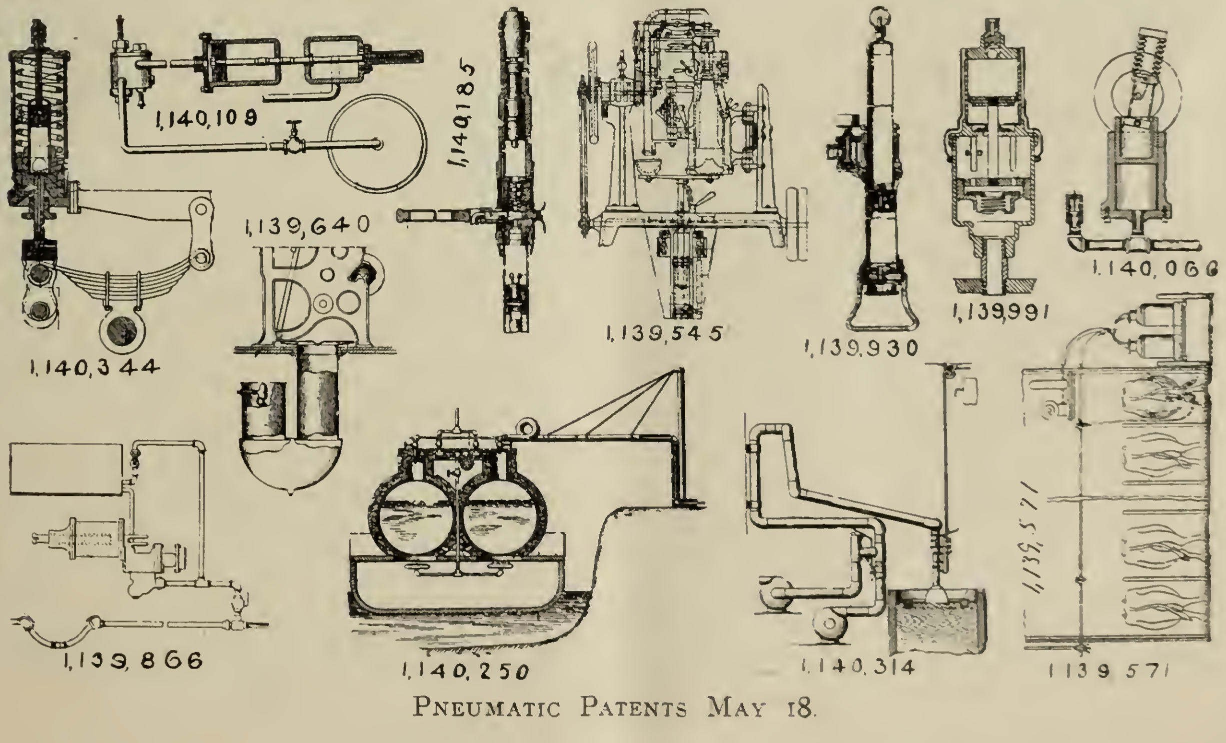
1,139,354. PROJECTILE FOR DESTROYING AIR-SHIPS, BALLOONS, AND OTHER AEROSTATS. REGINALD ARTHUR FEATHERSTONE-SMITH and MEHERJIBHOY BOMANJI COOPER, London, England.

1. A projectile for destroying airships and the like comprising a shell having an air passage extending therethrough toward the nose end and a gas passage extending therethrough toward the tail end, a gas igniter in communication with the gas passage, openable stops at the exterior of the shell, and an air blower in communication with the air passage.

1,139,358. AIR PURIFIER AND WASHER. CHARLES A. GEDDES, Philadelphia, Pa.

1,139,376. FLUID-PRESSURE BRAKE SYSTEM. WILLIAM H. SAUVAGE, New York, N. Y.

1,139,419. AIR-PUMP. ROLAND C. HILTON, Boston, Mass.



PNEUMATIC PATENTS MAY 18.

MAY 18.

1,139,545. AUTOMATIC MACHINE FOR BLOWING SEAMLESS BOTTLES AND OTHER ROUND VESSELS. George Lefort, Clabecq, Tubize, Belgium.

1,139,571. MILKING-MACHINE. Lewis Preston Paterson, Springfield, Mo.

1,139,589-90. MILKING APPARATUS. George Sinclair, St. Paul, Minn.

1,139,640. HUMIDIFIER. Frank B. Comins, Newton, Mass.

1,139,866. RELEASING MECHANISM FOR AIR-BRAKE SYSTEMS. Nicholas E. Hirsch, San Luis Obispo, Cal.

1,139,910. APPARATUS FOR CLEANING SMOKE TUBES OF MARINE AND OTHER MULTIBULAR BOILERS. Charles H. Shepler and Joseph W. Shearer, San Francisco, Cal.

1,139,930. PNEUMATIC PUMP. Aaron J. Tyler, Rochester, N. Y.

1,139,991. AIR-COMPRESSOR. William Mortimer Melmore, London, Eng.

1. In an air-compressor comprising a pump cylinder seated on the end of an operating cylinder to be connected with one of the cylinders of a motor vehicle, the combination with a pump piston, a rod depending from the piston, a disk-valve frictionally mounted on the piston rod, and means for limiting the travel of said valve, of an operating piston fast to said piston rod and comprising a perforated top plate, a centrally perforated cup-shaped piston body, a non-return valve at the inner face of said plate, and a spring for supporting the non-return valve, as described.

1,140,002. PNEUMATIC CUSHIONING DEVICE FOR VEHICLES. Earl V. Sanders, Pawnee, Ill.

1,140,065. MULTISTAGE COMPRESSOR. Auguste C. E. Rateau, Paris, France.

1,140,066. MILKING-MACHINE. Benjamin P. Remy and Frank I. Remy, Anderson, Ind.

1,140,185. POWER ROCK-DRILL. Frederick Perley Porter, Kellogg, Idaho.

1,140,250. MEANS FOR HANDLING AND TRANSPORTING LIQUID GAS. Godfrey L. Cabot, Boston, Mass.

1. In an apparatus of the class described, a supporting member, a pair of intercommunicating tanks mounted thereon, heat insulation completely incasing said tanks to retain the contents thereof at predetermined temperatures, means for simultaneously filling the tanks on either side thereof, an insulated pipe connection between said tanks, and expansion valves mounted in the length of said pipe connection for the escape of volatilized contents of said tank, for maintaining said other contents at a continuing low pressure.

1,140,294. VACUUM-CLEANER. Robert R. Smith, Philadelphia, Pa.

1,140,314. GLASS-BLOWING APPARATUS. Pierre J. Paquet, Salem, W. Va.

1,140,344. AIR-SPRING. John G. Funk, Swissvale borough, Pa.

MAY 25.

1,140,373. OXYGEN-GENERATOR. Thomas Griswold, Jr., and Edwin O. Barstow, Midland, Mich.

1,140,536. RIVET-SET RETAINER. Wendel H. Shipeer, New Castle, Pa.

1,140,618. SANDING DEVICE FOR STREET-CARS. William A. Sault, Worcester, Mass.

1,140,634. PNEUMATIC VALVE. Aaron J. Tyler, Rochester, N. Y.

1,140,645. PNEUMATIC CUSHION FOR AUTOMOBILES. Edward A. Wilcox, Carthage, Ill.

1,140,673. TUNNELING-MACHINE. Walter W. Giggey, Netherland, Colo.

1,140,699. AIR-PUMP. John J. Messerli, Kingsville, Tex.

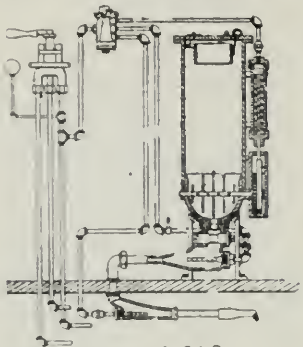
1,140,713. PRESSURE-VALVE. Bingham S. Price, Rawlins, Wyo.

1,140,723. COMBINED AIR-PUMP AND STARTER FOR EXPLOSIVE-ENGINES. Frank E. Ten Eyck, Auburn, N. Y.

1,140,939. PUMPING APPARATUS. Van P. Bailey, Indianapolis, Ind.

1,140,982. OPERATING OIL-WELLS. William D. Huff, La Fayette, La.

1,140,992. PNEUMATIC SUCTION-CLEANER. Emanuel A. Martin, New York, N. Y.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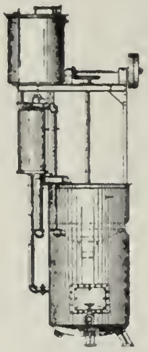
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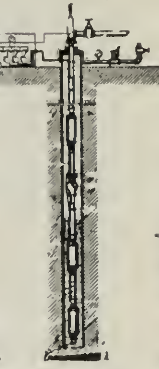
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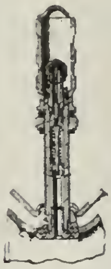
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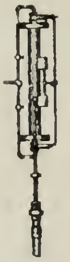
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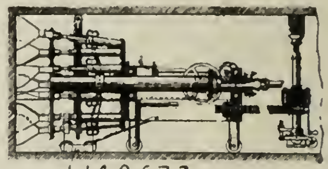
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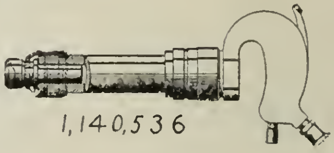
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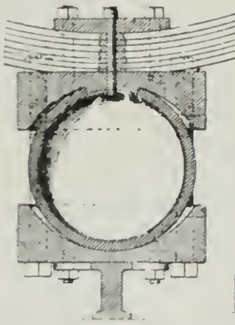
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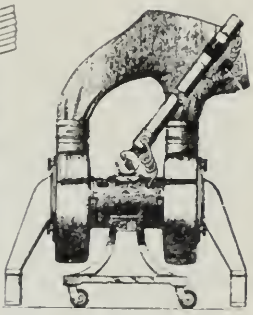
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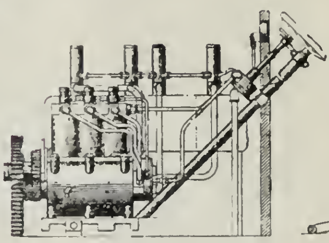
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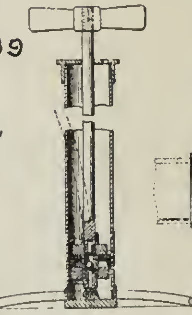
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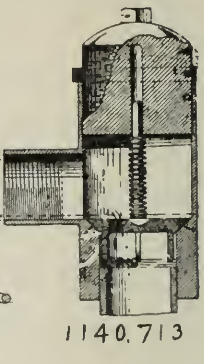
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Pneumatic Patents May 25.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XX AUGUST, 1915 No. 8

METAL SPRAY PROCESSES*

BY JOHN CALDER.

It is the object of this paper to describe the latest mechanical process, the Schoop process, for depositing electro-positive metals on iron and steel. Incidentally, the method permits the depositing of many other metals and alloys on coherent bodies whether metallic or not.

The process takes its name from M. U. Schoop, an engineer, of Zurich, who, in collaboration with other inventors, made the metal spray an effective coating agent. In the Schoop process, the coating metal adheres to the object chiefly by mechanical union. The metal is discharged in hot impalpable particles moving with high velocity and these when directed upon a prepared object penetrate the pores of the latter while the spray is still plastic. The coating metal thus dovetails itself into the superficial pores of the object and does so in the presence of reducing gas which prevents oxidation at the junction of the metals.

The progress of invention on metal spraying has been chiefly directed toward making the metallic particles as small and as hot as possible, thereby avoiding oxidation, and reducing the pressure of air used and the cost of the gases employed.

The evolution of the apparatus has been interesting. The liquid metal process involved a large non-portable reservoir of hot metal weighing with the auxiliary parts over a ton; the metal dust apparatus weighed over a hundred pounds, while the "pistol" of today weighs less than four pounds. Figs. 1, 2 and 3 show the three forms through which the apparatus has passed.

In the apparatus represented by Fig. 1, a molten metal is allowed to run continuously from the reservoir *R* through a broad nozzle *N*, where it is broken up and swept away by a violent current of heated gas *G*, issuing under regulated pressure from containers *C* and reheated in its passage at *H*. The expansion of the gas chills the molten particles and forms a rapidly moving spray or fog of metal which impacts upon any object placed in its path and plates it.

Any metal fusible under the conditions of the apparatus can be used and owing to the low temperature of the fog, it is possible to plate very delicate and easily combustible objects, as well as metal articles. Aluminum plating, which could not be obtained by fusion or electrolysis on account of its ready oxidation, was easily obtained by this Schoop process.

The obvious objections to such an apparatus were lack of portability and the expense of melting and keeping fluid most of the metals in the unavoidable intervals of spraying. The result was that only the more fusible metals, lead and tin, were used where spraying on a continuous scale was possible and the liquid metal apparatus was never reduced to economical practice. It was observed with this apparatus, however, that the particles were not actually molten at the moment of impact and this suggected the next step.

Fig. 2 represents the second form of apparatus in which portability was secured and the metal particles to be sprayed were prepared in advance. Powdered metals in a very fine state of division have many of the characteristics of a liquid. Their fine particles mix with one an-

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*Abstract of paper before the American Society of Mechanical Engineers, May 11, 1915.

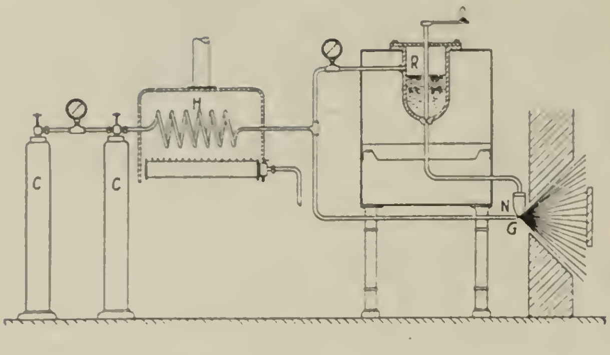

FIG. I.

other like drops, they spread with facility and unite under the influence of very little force. The metal powder in the container *C* is entranied in an air blast *A*, heated in the flame of a blast pipe *B*, and projected with high velocity. The gas is burned at *D* and the supply of air is regulated at *S* to obtain complete combustion.

It was found that the anticipations from the use of the first apparatus were correct and that metal particles projected in a pasty condition produced plating as before. Most metal powders, however, tend to oxidize rapidly and the use of this apparatus was practically restricted to tin and zinc on this account. Even with tin, the expense of metallic powder was prohibitive, but the plating with tin and zinc was very good. In the case of zinc, the apparatus known as the cyclone is still the most economical instrument for plating large surfaces with that particular protective metal. Zinc dust is a by-product in the stacks of zinc smelteries. With the Cyclone apparatus, it can be impacted on steel structures either in the field or at the factory.

Inventors then set themselves to overcome both the chemical and economic difficulties, viz.: to dispense with mass melting and dust preparation and to secure instant and simultaneous operation of melting and pulverization, and control with a handy, economical and easily transportable appliance. The result was the ingenious instrument known as the "pistol" which is shown in Fig. 3.

The principle involved consists, as shown in Fig. 4, in feeding a fine wire *W* of any metal into a reducing flame zone *Z* at such a constant speed that the position of the end of the wire *E* remains stationary, the melting rate being exactly equal to the rate of feed. Under such conditions the wire end melts a drop at a time and each drop at the instant of formation is struck a violent blow by an air blast *A*. In other words, the pistol is a machine gun which automatically manufactures its ammunition from a reel of wire and bombards the object to be plated with plastic projectiles of extremely small size.

The resulting fog or spray of fine metallic particles into which the drops are divided takes the form of a diverging cone *C* with a core of reducing gas *G* in which the particles are entrained, and a surrounding sheath of air *A* which is rapidly expanding and cooling. Any suitably prepared object placed in the path of this metallic spray is plated through impact without undue elevation of temperature.

Fig. 6 shows a section of the commercial spraying pistol now in use. The principal parts of the pistol consist of an outer casing *A*, cast of aluminum, with a central projecting tube forming a handle, a wire feed mechanism mounted entirely upon the cover *B* of the turbine chamber, the turbine *C* actuating the wire feed mechanism, gas, air and wire nozzles mounted upon the outer casing held in position by a hand nut *D*, and a re-

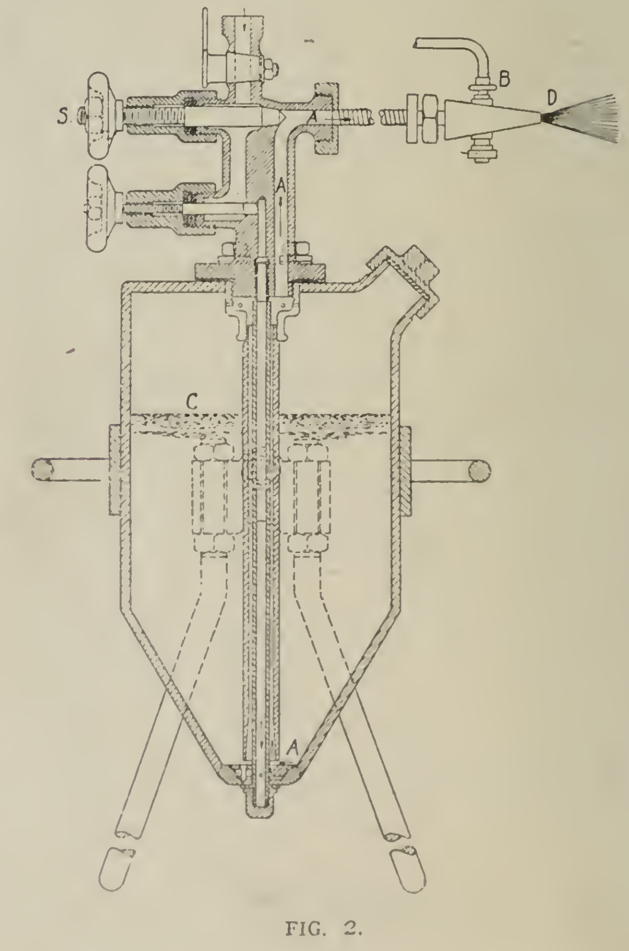

FIG. 2.

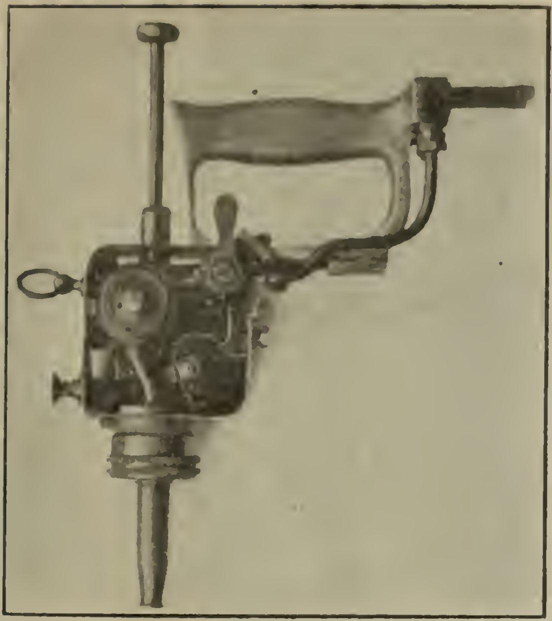

FIG. 3.

movable cover *E* which completes the enclosure of the outer casing.

Gas and air ducts are drilled in the outer casing. The flow is controlled by the tapered valve *F* provided with a handle *G*. The wire feed mechanism is actuated by a turbine *C* mounted on a vertical shaft running in ball bearings; a worm is cut in the upper end of the vertical shaft and drives by worm wheels the horizontal shafts *N* and *O*, Fig. 6, which are provided with worms in turn driving the worm wheels *P* and *Q*.

The wheels *P* and *Q*, Fig. 6, are provided with slots to engage the projecting lugs of the lower feed wheel *R*. The upper feed wheel *S* mounted in the pivoted frame *T* is provided with shrouds controlling the position of the lower feed wheel *R*. The lower feed wheel can be engaged in either worm *P* or *Q* by raising a clip *I*, shifting laterally in either direction and locked in by the opposite clip. The shift can be readily made by allowing the mechanism to run slowly by a slight opening of the starting valve.

Pressure is applied to the feed wheels through the pivoted frame *T* by a coiled spring, and controlled by the operator by means of the release lever *K*. The final adjustment of the wire feed is controlled by the needle valve *M*, Fig. 6. The turbine and shaft complete is assembled in the outer case and properly adjusted independently of the other mechanism.

The wire feed is entirely assembled on the turbine cover *D* and, when properly adjusted is secured in position. The wire nozzle base *U* provides an adjustment for position of wire and gas nozzles, and is secured in position by a headless set screw. The upper end of the stem of the turbine cover is provided with an annular groove, which is engaged by the spring loop *V* and secures the removable cover *E* of the case. Loop *V* provides also a means for hanging the pistol on a conveniently located hook.

The operation of the pistol is as follows: The gas and blast nozzles faces *B* and *C* are securely clamped to form gas tight joints by tightening the hand nut *D*. The end of the central or wire nozzle is then 0.015 in. inside the gas nozzle and the stationary melting point of the wire is 0.03 in. inside the air blast nozzle. The wire diameter used is from 0.0319 to 0.0375 in., except for lead and tin which are used in larger sizes owing to their rapidity of melting.

The feed gears having been set in mesh at the approximate speed required for the wire selected, the air alone is turned on and the speed tested with a short length of wire. Adjustment, if necessary, is made by the needle valve which modifies the speed 2 ft. per minute plus or minus.

The end of the wire reel is then threaded through the stock receiving tube, between the gripping feed rolls and into the central wire nozzle and the fuel gas pressures from the containers are adjusted by the reducing valves and gauges thereon to the tabular requirements for the metal to be sprayed. The pressures of the fuel gases seldom rise above one atmosphere and hydrogen or Blau gas are the reducing gases usually employed. This gas is now admitted by slightly opening the starting valve and when ignited with a match burns quietly as a pilot light.

The starting valve is then opened up full and oxygen is admitted gradually until the flame zone is established. All back-firing is avoided by keeping the reducing gas always in excess of the oxygen, the ratio being three

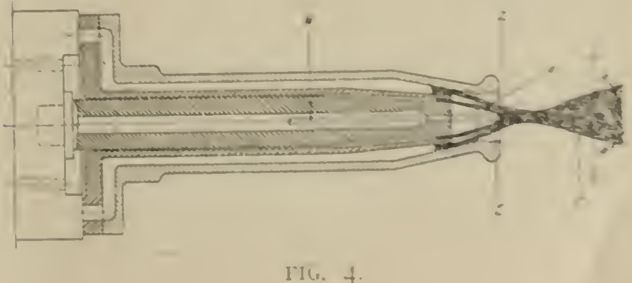

FIG. 4.

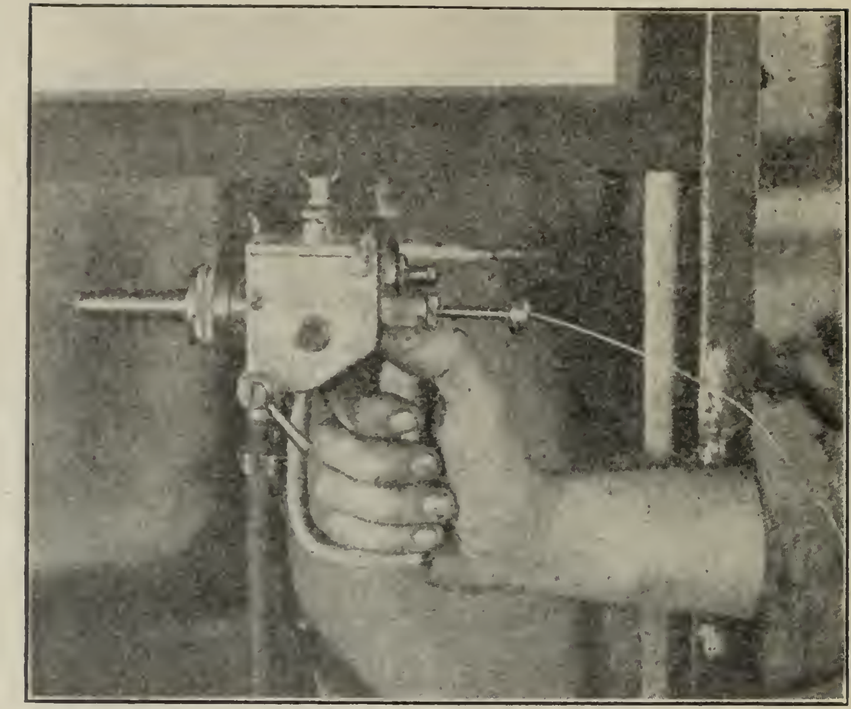

FIG. 5.

or four to one. The above movements are made in rapid succession on a light instrument which can be held in one hand and the spray is started up the moment the constant melting position of the wire is reached.

The spray so established is essentially a metal plating air-brush, the diameter of which 5 in. from the pistol end is about 2 in. Objects to be plated are operated upon by pointing the pistol normally to the surface to be coated at any moment at about 5 in. distance and traversing the pistol across the surface with a regular motion. A single coating is about 0.001 in. thick. The operator's vision easily guides him in distinguishing between the coated and uncoated portions and also between a first and second coat.

Two thousandths of an inch well impacted upon a surface are just as effective as a much greater thickness and of course unnecessary sprayed metal increases the cost, as the latter is directly proportional to the thickness. Not only on the score of economy but also to preserve toughness the coating should be of minimum thickness for the anvil action of the metallic spray on a solid metal object is lost above a few thousandths of an inch thickness and a process of cold working follows which produces a brittle scale readily detachable. In practice this matter is easily regulated.

Fig. 5 shows the pistol held in the hand ready for action with the wire thread in position.

Gas bombs with fittings and air at 40 lb. pressure are the only requisites besides the pistol and its hose connections for plating non-metallic objects such as wood, stone, paper, cement, cloth, etc. All metallic surfaces should have the scale cleaned off and their pores opened by preliminary sandblasting.

It will be seen from Table 2 that 0.001 in. thickness, one square foot in area, can be sprayed with the common metals for a small sum. The total cost for German silver is 3½ cents, for copper, 3 cents, for tin, 5 cents, for brass, 2¾ cents, for zinc, 2 cents, for aluminum, 1¾ cents and for lead 1½ cents per square foot.

Various theories have been offered to account for the plating properties of the metal spray, but it is believed by those putting it to practical use that, except in the few cases where the impacted metals have a chemical affinity, the action of the spray is purely mechanical.

Any metal wire can be sprayed with varying degrees of fineness by the pistol, but a hard metal, such as copper, cannot be impacted with the same degree of adherence upon a solid copper object as it would be upon a more porous cast iron object or upon one of the soft metals such as lead or zinc. The

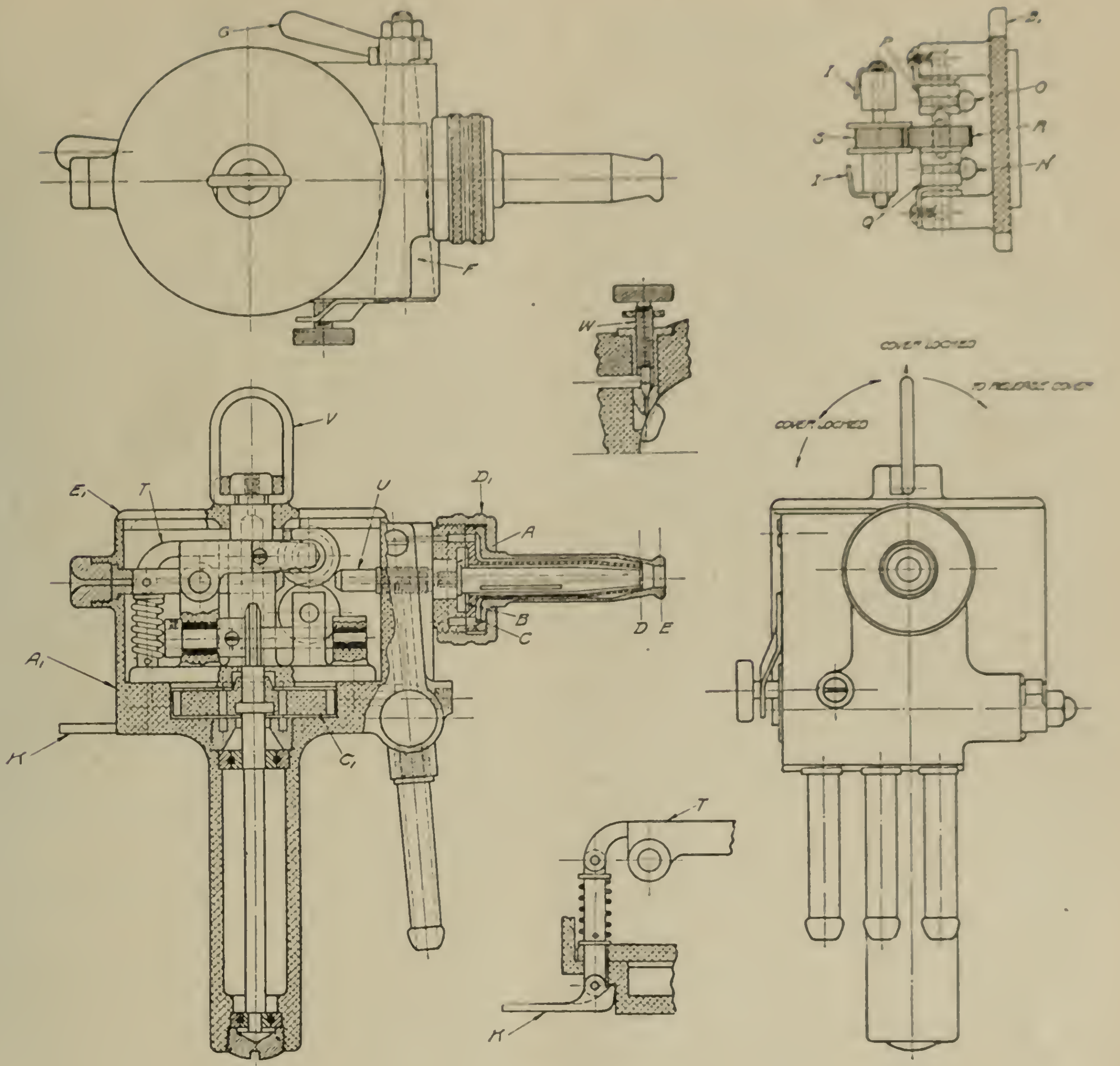

FIG. 6.

coatings may be ground, polished and buffed like any ordinary metals, but polished sprayings do not offer themselves as economical substitutes for cheaper and less adherent platings which are deposited in smooth condition.

As metal spraying is essentially a kinetic energy process the degree of adherence obtained in any instance depends upon the relative hardness and porosity of the sprayed metal and its base. For some decorative purposes this is of no consequence, but where stress, wear and chemical action are involved it is quite important to choose the appropriate coating.

In spraying where the softer metal forms the object, the body of it, as well as its superficial pores, will be penetrated by the harder metal with its projectile action. When the condition is reversed the softer spraying metal will fill the open pores of the harder object and key itself into the former in cooling off, but it will not penetrate the solid parts of the body. In either case, however, with proper preparation of clean open surfaces a durable adherent coating is obtainable.

The detachable coatings form an interesting study and have yet to be developed for many of the arts. It has been found that if the Schoop spray be turned upon a smooth greased surface of reasonable hardness, the bombarding fog of metal particles will remain upon the surface without impacting and will copy the surface to its finest line or detail. On cooling and tapping this reverse it detaches

TABLE 1 DETAILS OF THE COST OF USING METAL SPRAYING PISTOL ONE HOUR

METAL	Diameter, Inches	Speed of Wire in Feet per Min.	Pounds per Hour	OXYGEN			BLAU GAS			Labor per Hour	Cost of Air per Hour	Cost of Spraying	Wire Cost per Hour	Total Cost per Hour	Total Cost per Minute
				Gauge Pressure	Cubic Feet	Cost at $.02 Cu. Ft.	Gauge Pressure	Cubic Feet	Cost at $.008 Cu. Ft.						
Copper..........	.032	12	2.15	27	24	$.48	25	13	$.104	.30	$.20	$1.08	$.366	$1.446	$.0241
Brass............	.032	12	2.15	28	21	.42	26	14	.11	.30	.20	1.03	.335	1.365	.0228
Bronze..........	.032	12	2.15	27	24	.48	25	14.5	.116	.30	.20	1.09	.432	1.522	.0253
German Silver...	.032	12	2.15	28	23	.46	26	14	.11	.30	.20	1.08	.545	1.625	.0271
Aluminum.......	.0375	16	12	19	36	.72	16	13	.104	.30	.20	.32	.44	.76	.0127
Zinc............	.0375	18	4.3	15	20	.40	13.5	10	.08	.30	.20	.98	1.23	2.21	.0368
Lead............	.076	25	30	14	20	.40	12	8	.064	.30	.20	.964	3.00	3.964	.0661
Tin.............	.061	25	15	13	24	.48	14	10	.08	.30	.20	1.06	10.50	11.56	1933

TABLE 2 COST TO COVER ONE SQUARE FOOT BY SPRAYING

METAL	Diameter, Inches	Speed of Wire per Minute	Time to Cover One Square Foot		Thickness, Inches	Cost of Spraying	Cost of Wire	Total Cost
			Min.	Sec.				
Copper........	.032	12	1	10	.001	$.021	$.0076	$.0286
Brass..........	.032	12	1	10	.001	.020	.0071	.0271
Bronze........	.032	12	1	10	.001	.024	.0101	.0341
German Silver..	.032	12	1	10	.0089	.024	.0105	.0345
Aluminum.....	..	16	..	40	.001	.0128	.0042	.0170
Zinc..........	.	18	..	30	.0015	.0081	.0115	.0196
Lead..........	.076	25	..	25	.002	.0064	.021	.0274
Tin...........	.062	25	..	30	.002	.0088	.0875	.0963

TABLE 3 COST OF SPRAYING ONE POUND

METAL	Feet per Pound	Speed of Wire in Feet per Min.	Time to Spray One Lb.	Cost of Spraying	Cost of Wire	Total Cost
			Min.			
Copper.......	340	12	28	$.50	$.1725	$.6725
Brass.........	350	12	28	.47	.1625	.6325
Bronze.......	344	12	28	.53	.2225	.7525
German Silver	330	12	28	.51	.25	.6
Aluminum....	761	16	48	1.075	.37	1.445
Zinc..........	283	18	14	2.27	.33	2.60
Lead.........	50	25	2	.032	.10	.132
Tin..........	105	25	4	.07	.70	.77

readily and by using it as a mold and repeating the treatment with a film of grease, a detachable copy of the original object, a coin, medal or any relief subject can be obtained in any desired metal.

Tables 1 to 3 show the data of gas consumption and total cost of spraying a square foot 0.001 in. thick of some of the commoner metals by means of the Schoop pistol; also, the cost of spraying per pound and by the hour and the rate of deposition.

[When the paper, of which only an abstract is given above, was presented at a regular monthly meeting of the American Society of Mechanical Engineers in the Engineering Societies Building a practical exhibition of the process in operation was given in the basement. Various objects were coated by the spray the favorite souvenir being a metal coated visiting card "sprayed while you wait."]

FRESH AIR PARADOXES

It is an undeniable fact that a room filled with air which, so far as chemical analysis can detect, is absolutely pure may feel very stuffy. For instance, the House of Commons, on the ventilation of which the author has experimented for many months for the Committee of the House, the air in the debating chamber is, chemically speaking, as pure as in any room in the world. Fresh air simply pours into it in extravagant volumes. In a moderately full house there are no less than 13,000 cubic feet of air supplied per head per hour. Yet it produces, without any possible doubt, the effects which we are accustomed to think of as associated with defective ventilation—lassitude, sleepiness, infection, and so forth. Complaints are loud and quite general. A room may, on the contrary, feel fresh and sweet in which, judged by chemical standards, the air is very bad. The author has analyzed air containing 25 volumes per 10,000 of CO_2 which felt as fresh as a spring morning, although 10 volumes is regarded as the extreme allowable impurity in current science. There must be some combination of chemical or physical conditions which accounts for the effect, so far as it is objective; when it is purely subjective, of course, it is impossible to analyze the effect. Nobody up to the present has ventured to specify what is that combination.—*A. H. Barker, Transactions of the Society of Engineers.* (British).

THE TESTING OF AIR COMPRESSORS*

When considering the purchase of an engine or machine of any description, the intelligent buyer not only looks upon the first cost, but also on the really more important question of running efficiency, and, therefore, besides obtaining an estimate of the price of the plant, he generally requires some guarantee of efficiency. In addition to this, in order to put a check on the optimism or possible deception on the part of the manufacturer, he specifies some test which will show him whether the guarantees given have been fulfilled. The methods of testing have become a matter of common practice with most classes of machinery. The steam engine is indicated and the steam consumption measured. The gas or oil engine is generally tested by brake, in addition to the taking of indicator cards and the measurement of fuel consumption; while with electrical machinery, the accuracy of electrical measuring instruments has rendered the testing of such plants a matter of exact science. With the air compressor, however, the position is somewhat different. Although there are considerable opportunities for loss in the transformation of heat or electric energy into the form of compressed air, there is a great deal of ambiguity in the method of guaranteeing efficiencies for this type of machine, and frequently very little care is taken to ensure an accurate test.

In the present day compressed air has a very wide field of utility in the operation of underground mining machinery, also in working pneumatic tools in shipyards, steel works, etc., and it would seem of no small importance to the user of such plants, and also the manufacturer, to standardize both the way of stating the efficiency of the machine and the method of testing it on completion. Usually there are three things specified in some form or other concerning the expected performance of an air compressor, namely, the volumetric efficiency, mechanical efficiency, and the power consumption for any given quantity of free air at the required pressure.

VOLUMETRIC EFFICIENCY.

The volumetric efficiency, which is very often treated as of greater importance than it deserves, is, of course, merely the ratio expressed as a percentage between the actual volume of free air compressed in a unit of time, and the volume swept by the first-stage piston or pistons in the same time. While it is important to the manufacturer to obtain a high volumetric efficiency, as this means that the size of the cylinders and consequently of the whole machine is reduced to a minimum for any given duty, it is not of paramount importance to the buyer, except in so far that a high volumetric efficiency tends towards a high mechanical efficiency and low power consumption. It is of very little moment to the buyer whether the cylinders of his compressor are large or small, within reasonable limits, if at the same time his machine will give the required output with small consumption of energy, and, in fact, it might even be a matter of suspicion if an exceptionally high volumetric efficiency was specified, as in such a case the cylinders worked out on this assumption might prove on careful testing to fail to give the full quantity of air specified.

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*The Engineer, London.

Of the two main causes of loss of volumetric efficiency, excessive clearance and excessive heating, the latter is by far the most important, for while the former merely reduces the quantity of free air taken in per stroke, the latter also entails an actual loss of energy; this lost work being converted into heat, carried away by the cooling water or dissipated by radiation from the cylinders and pipes. It is, therefore, in this direction only that a high volumetric efficiency tends to economy in working, but, as will be explained later, this economy in working can be indicated more definitely in other ways. It may, however, be here stated that the volumetric efficiency obtained in well-designed compressors may be as high as 98 per cent. for large units.

MECHANICAL EFFICIENCY.

Dealing with the second efficiency mentioned, namely, the mechanical efficiency, this expression appears to be invested with a different meaning in different cases, and we also sometimes meet such expressions as "commercial efficiency," which, while being a form of the former, has no generally accepted meaning or definition. As most commonly understood, the term mechanical efficiency is taken to mean the ratio of the *air* indicated horse-power to either the indicated horse-power of a steam-driven compressor or the brake horse-power at the compressor shaft in the case of a compressor driven by electric motor. Not quite the same thing, as the ratio $\frac{A\ H\ P}{B\ H\ P}$ is generally higher than $\frac{A\ H\ P}{I\ H\ P}$, for the reason that this last must take into consideration the losses due to friction, etc., of the steam engine portion of the compressor, with its steam valves, governor, etc., which are absent with the electric drive. It will be seen that in either case these figures are based on indicator diagrams, and while the indicator applied to air compressors gives most valuable information, and indicator cards should always be taken, the results obtained are by no means conclusive from the buyer's point of view. Either of the ratios mentioned above, taken in connection with other information, give considerable assistance in comparing the merits of a compressor, but it must be remembered that a high mechanical efficiency can be equally well given by a *high* air horse-power as by a *low* brake horse-power or steam indicated horse-power. It can be easily conceived that an inefficient compressor showing an unnecessarily high air horse-power for a given output, when compared with the brake horse-power at the motor shaft, may show a very fair efficiency, while at the same time it may be very uneconomical in power consumption.

POWER CONSUMPTION.

We come now to the third and most important form of guarantee from the buyer's point of view, namely, the power consumption for any given quantity of free air compressed to the required density. This is analogous to the steam consumption per indicated horse-power of a steam engine, in the same way that the mechanical efficiency, as explained above, is analogous to the mechanical efficiency of a steam engine, the former giving an indication of the cost of production of a definite quantity of power, while the latter merely indicates how much of the lost power is due to engine friction, and in an air compressor the power lost in friction is usually a very small portion of the total loss incurred in the transformation of energy into air pressure.

It is the usual practice of builders of air-compressing machines to state the power consumption, either in brake horse-power at the compressor shaft or indicated horse-power of the steam engine, for electricity and steam-driven compressors respectively, and this information may be most suitably converted for the purposes of comparison into cubic feet of free air per minute compressed to the required pressure per brake horse-power or indicated horse-power input. This is certainly the expression which will convey to the user in definite figures the cost of running his plant. A compressor of modern and efficient design will require one brake horse-power at the shaft for about $5\frac{1}{4}$ cubic feet of free air compressed to 100 lb. per square inch. A larger or smaller expenditure of energy will be required when the final pressure required is lower or higher than 100 lb.

The most scientific way of stating the efficiency of a compressor is to compare the actual brake horse-power absorbed at the compressor shaft with the horse-power which would be theoretically required to compress the given quantity of air to the necessary pressure under ideal conditions. This absolute standard of comparison is best taken to be the theoretical horse-power required when the air is compressed isothermally. Of course, as need not be explained here, isothermal conditions are never obtained in practice, and actually the compression curve approximates more closely to an adiabatic curve. Still, isothermal compression represents the desired ideal, and has the necessary qualification for purposes of comparison, of being invariable for any given quantity of air and pressure. The formula for the horse-power required when the air is compressed isothermally is well known, and may be stated here as

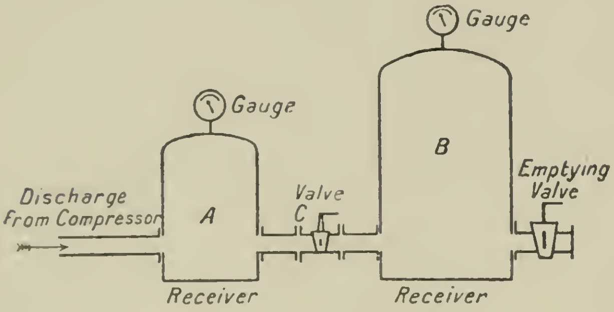
$$HP = \frac{144}{33{,}000} \times P^1 V \left(\log_e \frac{P^2}{P^1} \right);$$

where $P^1 =$ initial pressure (usually that of the atmosphere, 14.7 lb. per square inch), $V =$ free air volume, and $P^2 =$ final pressure. On this basis the efficiency

$$\frac{\text{A H P (isothermal)}}{\text{B.H.P.}} \times 100$$

in practice varies between 60 per cent. and 80 per cent., depending very much on the size of the unit under consideration. Large, slow-speed compressors frequently show the higher efficiency mentioned, and smaller high-speed machines the lower. This gives a very convenient expression for the efficiency of an air compressor, which might be with advantage generally adopted. For purposes of investigation, the *isothermal* air horse-power may be compared with the *indicated* air horse-power, as the ratio obtained in this way will give a measure of the losses which occur in the actual compression of the air, independent of frictional and other mechanical losses in the machine.

To return, however, to the buyer's point of view, he purchases a compressor which is guaranteed to compress a certain quantity of free air to the required pressure with a consumption of power not exceeding the specified amount. He may, therefore, very reasonably desire to test the machine either at his own, or the maker's works, to see that these conditions are fulfilled. To do this, the air pressure obtained is easily measured by a suitable gauge. The horse-power absorbed, also, is found by taking indicator cards from the steam cylinders in the case of a steam-driven compressor, or by electrical measuring instruments, when the machine is to be driven by an electric motor. The only difficulty is the measurement of the quantity of air compressed, and the easiest and most reliable way of doing this is by means of a suitable receiver, the capacity of which has been carefully calibrated. But here a difficulty presents itself. It is quite usual to discharge the air into one receiver, noting the time which is taken in raising the pressure of the air from that of the atmosphere to the required final pressure. It will easily be seen that this is not a test under practical working conditions, insomuch as the quantity of air measured in the receiver has not all been discharged at a constant pressure, and that the specified final one desired. For, at the start, the compressor is only discharging against atmospheric pressure, and it is not until the test is completed that it has to pump against the maximum working pressure. The horse-power absorbed will, therefore, vary throughout the whole period of time required to raise the pressure in the receiver to the required intensity. However, this method of ascertaining the actual output from a compressor is very generally adopted, and it is pointed out that, if the horse-power measurements are taken at a moment approaching the end of the test, fairly accurate results are obtained. But quite apart from the question of power consumption, it is not an accurate test of the actual volumetric capacity of the machine, and it is quite possible that, while a compressor will deal with the requisite volume of air when tested under these conditions, it would fail to do so if the discharge had to be maintained continuously, during the test against the maximum working pressure. For, during the commencement of the trial, when the receiver pressure is low, none of the most active causes of loss in volume come into full force. The heating of the air is neglible at low pressures, as is also the leakage past the valves, etc. Again, at higher pressures, the loss of volume due to the re-expansion of the air imprisoned in the clearance spaces has a greater effect. It is almost un-necessary to labour these points, and it may be assumed that the right way to carry out a test is to measure the air in a receiver which has been filled against the maximum working pressure, this pressure remaining constant during the whole period of the test. This may easily be done by means of two receivers in series, as shown in the accompanying diagram. The discharge from the compressor is led first into the receiver A, which is filled with air until the gauge attached reads the required pressure, the valve C being closed meantime. As soon as this pressure is reached in A, the valve C is opened just sufficiently to maintain this pressure. The amount of opening at C will then be just sufficient to pass the full discharge of the compressor, which will flow into the second receiver B; the time being noted between the opening of the valve C and the moment when the gauge on receiver B also indicates the specified pressure. This will give the time occupied in filling this receiver, the capacity of which is known, against a constant and predetermined pressure. From this it is a matter of simple calculation to obtain the rate of discharge from the compressor By means of opening additional discharge valves on A and B, and closing valve C, B may be emptied, and when the pressure of its contents has fallen to that of the atmosphere, it may be refilled, and the test repeated as many times as may be thought necessary. With care in manipulating the valves, any serious alteration of the discharge pressure can be avoided, so that measurements of power consumption can be taken continuously, and a full load test of the compressor extended over several hours. The only objection to this method of testing is that of the cost of providing two receivers, but it will be seen that the first vessel A need only be large enough to ensure a steady pressure reading, and even a sufficient length of piping will serve. The final receiver B should be as large as can be arranged for, to ensure accuracy of results, and should be carefully calibrated.



MEASURING AIR OUTPUT.

It need not be pointed out that the volume of air at the working pressure to be measured must be calculated from the free air volume specified for the compressor, and the usual corrections made for temperature. A suggestion will at once present itself, namely, that the valve C, between the two receivers, is empirically adjusted to given an orifice capable of just passing the required volume of air which is flowing from the first receiver under the specified working pressure. It would, therefore, be quite practicable to measure the flow from a compressor by means of an orifice of calculated area at the outlet of the first receiver. This is, in fact, sometimes done. In order to calculate the area of this orifice correctly, the coefficient for the jet must be known, as in the case of measuring the flow of water over a weir. Unfortunately, there do not appear to be any data available for this purpose, and it would require some experimental tests to obtain the necessary information.

There is one other point worthy of note in connection with the testing of air compressors That is the measurement of the power consumption at light loads. Owing to the fact that an air compressor frequently works a great part of its working life at a load considerably less than its full rated capacity, it is very important that such a machine should be economical at light loads. A compressor may take very little power to drive it when delivering the full specified quantity of air, and at the same time be extravagant of power on light loads, with the result that it will prove to be uneconomical in running on the average load under working conditions. It is, therefore, advisable that the buyer should obtain a guarantee of power consumption at light load, and carefully test the machine at varying loads.

LOST MOTION IN ROCK DRILLING

BY LETSON BALLIET.

The energy delivered by the human power plant is far more expensive per horsepower hour than that delivered by the mechanical power plant.

There are many expert mathematicians among the mining engineers, but if we assign a problem asking what per cent. of the motions made by the human power plant are lost or wasted motions, we fear that there are few who can solve the problem.

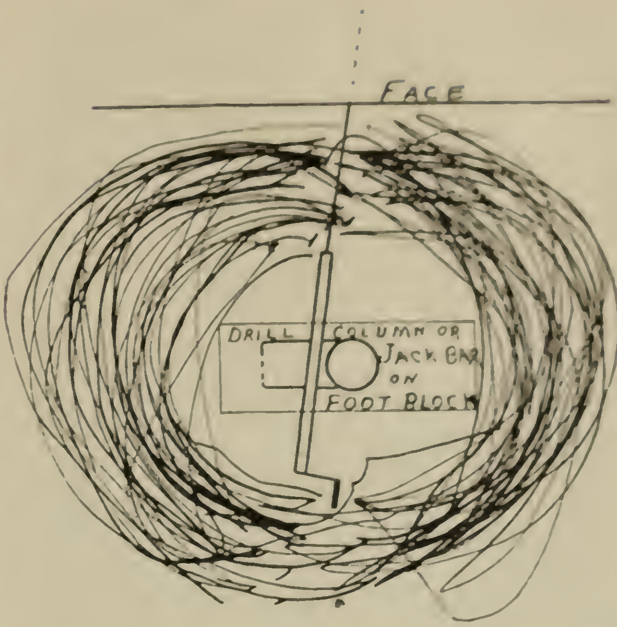
The lost motions and wasted energy of the human power plant are not only fatiguing, but mentally discouraging to the workers. Efforts without result are heart-breaking to the workman. No man can accomplish the same amount of work when he is discouraged as when every motion counts. It is the question of results that makes his labor efficient or inefficient.

Mining is now prosecuted, almost entirely, by means of machine drills, and we will admit that they have a great advantage over hand drilling, but the manufacturers of machine drills have rested content with the primary arrangement apparently without attempting to bring out anything more convenient.

ROCK DRILL INEFFICIENCIES.

One excessively inefficient point of the machine drill is the feed-screw operated by a crank from behind the drill which keeps the machine operator from 4 to 6 ft. away from his work. This disadvantage is serious when machines are to be operated by one man.

As a matter of graphic illustration a chart has been prepared showing the foot of the jack bar on its foot block, while the diagram which accompanies it shows the path of the operator in his trips around the drill column. Part of the time he had to crawl under the drill arm, or the air hose, and part of the time he went the other way around. Of course, it would make it easier walking if he were provided with a large rubber mat to surround the jack bar, but it wouldn't eliminate the lost motions. It would seem that if the drill was so designed that the cranking could be done from the forward side of the shell, or from beneath the chuck, that several hours of time could be saved that are now spent *traveling around the jack bar*. This travel around the jack bar ordinarily means from 3 to 5 steps, or perhaps a distance of 8 or 10 ft. of actual travel each way.



THE DRILL RUNNERS TRAVELS.

Let us assume that the driller goes forward, or changes sides 25 times in 8 hours, moving a distance of 8 ft. with each change while putting in a round of 10 or 12 holes in hard ground. This includes changing steel, tightening chuck nuts, releasing drills that stick in the holes, throwing water with a can or dipper into the hole, adjusting hose connections or water feeds of some kind, throttling and cranking the machine, etc.

Seventy-five trips around the machine 8 ft. each way, or 16 ft. for the round trip, computes nearly a quarter of a mile of travel over hose and blocking, stooping under the drill or the arm, etc. The question is: Why don't you take up some of that quarter mile of lost motion if you are so particular about a sixty-fourth of an inch in the crank pin of an engine or compressor?

If you are in doubt as to the accuracy of these figures, take a piston drill into a hard face, say nothing to the operator, but check up his lost motions in traveling around the column from the set-up to the tear-down, and see for yourself the chart you can make

Use a stop-watch and see how much time he uses in changing position. Notice the number of times he hammers the drill steel with the chuck wrench to release it when it sticks, while if he was standing alongside of the steel he could keep cranking and hammering at the same time.

SOME HORSE-POWER FIGURES.

You are paying perhaps from 1 to 5 cents a horse-power hour for steam, gasoline or electric power, and you make strenuous efforts to save a fraction of an inch of lost motion. You are paying 50 cents per man-power hour, and waste a quarter of a mile of lost motion.

If 33,000 ft. lb. per minute equals 1 h. p., we will take the actual work of loading a car to figure how much horse-power the average man develops. One man loading a 1-ton car raises 150 shovelfuls of muck to a height of 4 ft., and loads the car in 10 minutes. Thus the man lifts 2,000 lb. 4ft., equaling 8,000 ft. lbs. This would be practically one-fourth of a horse-power if done in one minute, but as it took 10 minutes the man's working rate was one-fortieth of 1 horse-power. Under the conditions existing in most mines the human labor actually figures about one-fortieth of a horse-power, and if paying the man 50 cents an hour, or $4 a day, the human power plant is costing $20 per horse-power hour.

Now the question arises: Why do you figure your mechanical power down to a few cents per horse-power and struggle to save a fraction of an inch of lost or wasted motion, while you allow miles of lost motion in the human power plant where the power costs $20 per horse-power hour?

This article is frankly aimed at the drill manufacturers, calling attention to the increased efficiency they could develop if they would design their drills so that the feed screw could be cranked from the forward end of the shell. This could be very simply arranged through gears, a worm or a ratchet, or by having a skeleton shell with the feed nut low enough to allow the crank to be turned underneath the chuck, or perhaps a little to one side. This construction is up to the drill makers, and if the mining operators will demand this arrangement of the feed screw they will greatly simplify the problem of the 1-man drill, and do away with chuck tenders.

TO KEEP THE DRILLS WORKING.

Careful timing of mounted rock drills, over a long period of time, shows that the drills are not working one-third of the time. Setting up, shifting, changing steels, getting water, getting steel, oiling, cleansing, fighting with stuck drills, tearing down and blasting, take up more than two-thirds of every drill shift.

The inventive ability of the drill makers is working upon the short end of the subject, when they try to make improvements that will result in more holes by faster cutting machines. It is true that faster drilling has some advantages, but if a round of holes is a shift's work," the reduction of drilling time to 25 per cent. of the 8 hour shifting simply leaves 75 per cent. of the shift for dead work. To blast ahead of time is often dangerous, and to wait for the smoke to be cleared out uses the rest of the shift, anyway. To put in deeper holes and blast a bigger round is often more inconvenient than a shorter round, for there is but little use in blasting out more than a mucker can clean up on his shift.

As it is shown that 66 to 75 per cent. of the time occupied on a drill shift is dead work, performed by human power, while 33 per cent. of the time only is the machine using air power, it would seem that some inventive effort would be put forth to make a quick and easy set up, a quick and easy method of changing steel, and a quick and easy method of shifting the machine on the bar.

We simply cannot see why so much effort is given to save a small part of the drilling time, while no effort at all is put forth to save any of the larger percentage of wasted time when not drilling.

[The above suggestive article, reproduced in somewhat condensed form from *Mining World*, provokes the question as to why it was not written a few years earlier. Instead of trying to cobble up some contrivance for turning the feed screw by the other end as suggested the drill builders have done much better than this and have given us air-feed drills, and the Jackhamer which has no mechanical feed at all and does more work than any of them.]

Simultaneous blasting is estimated to be 25 per cent more effective in breaking rock than the firing of holes consecutively.

CHEAPER AND BETTER THAN ACETYLENE

BY J. F. SPRINGER

The gases commonly employed in autogenous welding and cutting are oxygen, acetylene and hydrogen, all of which are expensive products. The average cost of oxygen throughout the United States is probably not less than $0.025 per cubic foot measured at atmospheric pressure; the average cost of acetylene probably ranges from $0.0075 to $0.01 per cubic foot; and the cost of hydrogen may safely be placed at about the same figure. Apparently no one has yet devised a system of oxygen manufacture that will enable this gas to be inexpensively produced. However, there appears to be a likelihood of heavy reduction in the cost of the fuel gas used in autogenous welding—not through a reduction in the cost of acetylene or hydrogen, but through the discovery of an adequate substitute for these gases. This substitute is a semi-natural gas obtained from the waste gas from oil wells, and is known as "gasol." It can be produced at about $0.001 per cubic foot, and its heating capacity is even greater than that of acetylene. Other things being equal, this gas selling for $0.0008 to $0.001 per cubic foot should have a considerable advantage over acetylene or hydrogen selling at $0.008 to $0.01—ten times as much.

Name of Gas	Cubic Feet of Oxygen required to burn one Cubic Foot	Heat Value in B. T. U. per Cubic Foot	Cost of 1000 B. T. U.
"Gasol".......	2	2300	$0.00162
Blau Gas. ...	2	1800	$0.00213
Acetylene	1½	1500	$0.00217
Hydrogen.....	2	500	$0.008

COMBUSTION FIGURES FOR DIFFERENT GASES.

Note: The above figures are based on the following prices: oxygen, 1½ cent per cubic foot; "gasol," 10 cents per pound; blau gas, 10 cents per pound; carbide, $70 per ton; and hydrogen, 1 cent per cubic foot.

In addition to the advantage in price, there is an economy in handling this new fuel gas. It is collected at the point of origin and compressed into liquid form, the liquid gas being shipped to the user in a suitable steel container. As the weight of the liquid gas in a container is equal to the weight of the container, an economy is effected in transportation costs. The gas issuing from the oil well, which is collected and compressed into the liquid form, is of variable composition, containing various percentages of hydro-carbon gases. The constituents of a typical sample of the crude gas as collected at the oil well include gases known as methane, hexane, butane, propane, and ethane mixed with more or less water and vapor. These constituents of the crude gas may be liquefied by the application of various amounts of pressure, the temperature remaining the same; or they may be brought to the liquid form by reductions in temperature, when the pressure remains constant.

All the gases with the exception of methane may be liquefied by the application of a moderate pressure under ordinary temperature conditions. But at 10 degrees F. it requires a pressure of 2700 pounds per square inch to liquefy methane, and this is obviously beyond commercial possibilities. At the maximum temperature which the gas will encounter during transportation, the pressure necessary to bring about the liquefaction of methane is impractical. The expense of the container would either be prohibitive or there would be a constant danger of the container exploding. These considerations make it necessary to eliminate the methane from the crude gas before it is liquefied, and as the heating value of methane is considerably below that of hexane, butane, propane or ethane, the elimination of the methane results in the production of a residual gas of higher heating value. However, the heating value of methane is not to be despised, and this gas is used in the locality where the residual gas is liquefied.

By applying a pressure of from 850 to 900 pounds per square inch to the residual gas at ordinary temperature, the gas will be brought to the liquid condition. This pressure can be readily obtained in practice and the cost of containers which will safely withstand the pressure of the gas is not excessive. The liquid gas has a specific gravity of about 0.5, or one-half that of water. One quart of the liquid weighs about 1 pound and produces approximately 10 cubic feet of gas. The containers in which the gas is shipped weigh approximately 100 pounds and have a capacity for 100 pounds of the liquid; accordingly, they hold approximately 1000 cubic feet of gas, which has a total heating value of about 2,000,000 B. T. U.

Natural gas requires an unusually large

amount of oxygen for its combustion, but the gas evolved from the "gasol" liquid contained in the cylinders requires still more oxygen for its complete combustion. As a result, it will be evident that the burner of the welding torch must be designed to deliver a higher amount of oxygen relative to the fuel gas than is the case where acetylene is used. At first thought, it may appear that the relatively higher consumption of oxygen will largely offset the advantage of the lower cost of the fuel gas. This is not the case, however, as less of the liquid gas is used to do a given amount of work because its heat value is relatively higher than that of acetylene. A further economy would also be effected through saving the first cost and maintenance expense of an acetylene generating plant. In the event of this substitute for acetylene finding wide application, the manufacturers of cutting and welding equipments would not be seriously affected, as essentially the same type of apparatus could be used. No doubt it would be necessary to make certain modifications in design, a case in point being in respect to the relative cross-sectional areas of the oxygen and gas ducts in the torch, but aside from changes of this nature, the welding and cutting of metals with "gasol" would be the same as when acetylene is used.—*Machinery.*

CEREAL DUST EXPLOSIONS

BY DAVID J. PRICE.*

A total of 19 explosions that have occurred during the past 10 years have been carefully studied and investigated, with a view to determining the causes and circumstances under which they occurred. Of the 19 explosions referred to, 11 have taken place since this work began in August, 1913. Since we have a record of only 8 explosions of this nature from 1905 to 1913, and a larger number in the short period from August, 1913, to the present time, we may reasonably conclude that the recent occurrences have been given special notice and attention since the study began, or that modern advanced and improved mills are experiencing more occurrences of this nature at this time.

It is reported that as a result of these explosions at least 80 men were killed and 125 injured, with a property loss exceeding $2,000,000.

SUPPOSED CAUSES OF THE EXPLOSIONS.

The establishing of a direct cause of a cereal-dust explosion by investigation directly following the occurrence has been found in some cases to be extremely difficult, while in others certain lines were distinctly defined and definite causes could be fairly well determined. The result has been that in a large number of cases the cause could not be definitely established.

Eight explosions were thought to have originated from sparks produced in the machine during the grinding process, one was attributed to production of static electricity, and in the remaining 10 occurrences it was not possible to establish a definite cause of the origin.

Although it has been claimed that sparks produced by foreign matter in the grain fed to the grinders might not possibly be sufficient to ignite the dust, the evidence in the majority of cases referred to was conclusive as to this particular cause. In order to definitely determine the relation of the sparks produced in this manner and a suspended dust cloud, an experimental mill has already been erected at Pennsylvania State College.

It is not possible to state at this time what effect a high ash content has upon the inflammability of "cereal dusts," for no work has yet been done along this line; but it has already been found that elevator dusts with as high as 16 per cent. of ash are very inflammable and develop high pressures on ignition.

From the investigations already conducted relative to the causes of cereal-dust explosions that have occurred in recent years in this country and abroad the following causes may be advanced:

1. Introduction of foreign materials into grinding machines.
2. Use of open lights or naked flames, such as oil lamps, torches, gas jets, lanterns, candles, matches, etc.
3. Property fires.
4. Electric sparks from motors, fuses, switches, lighting systems.
5. Static electricity produced by friction of pulleys and belts, machinery parts, grinding machines, revolving reels, etc.

STATIC ELECTRICITY.

The first four causes given may possibly be generally accepted but the advancement of the last cause, namely, "static electricity" has opened, as it were, a new field

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In September, 1913, on a dry frosty morning in early fall two slight explosions occurred in separate plants in Western New York, at a time when the feed had been shut off from certain grinding machines. The occurrences took place after considerable lapse in time after the stream of grain had stopped entering the machines. The possibility of "static electricity" being produced by the operation of the revolving plates of a machine suggested itself in a very preliminary way at the time of these occurrences.

Although up to that time experiments had not been conducted to determine whether cereal dusts could be ignited in this manner, it was found by experiment that sufficient static electricity could be produced by friction of a very small pulley and belt to readily ignite natural gas. It was learned at this time that a milling company in the South, engaged in grinding cotton-seed cake into meal, after experiencing a series of explosions, had prevented a repetition of previous occurrences, by grounding the grinding machines, by means of a wire connected to a rod driven in the ground nearby. This confirmed the original theory and indicated the practical success of a grinding device of this kind.

The possibility of static electricity as a source of cereal-dust ignition was very clearly established by an explosion in the dextrine department of a starch factory in one of the Eastern States in September, 1914. The origin of the explosion was traced to the production of static electricity by friction of particles of dextrine on 80-mesh brass gauze surrounding a revolving reel. This reel was only revolving at the rate of 16 revolutions per minute at the time of the explosion.

It is of very great interest to note in connection with this explosion that the company had grounded this reel to an overhead sprinkling system at the time of this explosion. It was found during the investigation, however, that the connection was made from the journal box, and that a heavy film of fresh oil surrounded the shaft. This was thought to have served to insulate the shaft and allow the static to accumulate within the reel until there was sufficient charge to ignite the dextrine dust.

It has recently been found by an English scientist that if a cloud of dust is blown against an insulated conductor (a wire for instance) the wire becomes charged with electricity, and under certain conditions it may become so highly charged as to give off sparks

HOW DUST EXPLOSIONS ARE POSSIBLE

It has been difficult for many to understand in what manner a dust explosion can occur without the presence of inflammable gas at the time of ignition. We may be able to simplify the explanation by stating that we might try for some time with great difficulty to burn a block of wood with a lighted match. If we take a knife and chip the block the shavings will ignite more quickly. We might make excelsior of the block and would find it would ignite still more readily, and so on by gradual reduction to a degree of fineness until dust is produced, when we find that the mass will burn rapidly when in suspension and diffusion with air.

The predominating factor which determines the inflammability of a dust and the action of a dust explosion has not been determined. A number of theories have been advanced, including the amount of volatile matter in the various dusts, together with the percentage of moisture and ash; the rate, or ease, of oxidation and the degree of fineness of the dust. All these have no doubt a marked relation to the action and nature of a dust explosion, and are at present receiving careful attention from the chemists experimenting along this line

PROPORTIONS OF THE EXPLOSION MIXTURES.

Since experiments have shown that the cereal dusts will ignite and propagate a flame, it will be of interest to consider the question of the amount of dust necessary to propagate a flame. In some of the experiments the dust was diffused in the proportion of .035 ounce per cubic foot of air space, and high pressures developed with the mixtures. To obtain the same proportion of dust and air, producing a mixture as inflammable as used in these experiments, it would be necessary to have only about 10 pounds of the dust in a closed room 10 ft. by 30 ft. by 15 ft.

EXPERIMENTAL EXPLOSIONS.

It is interesting to note at this time that, following the explosion in Minnesota in 1878.

Profs. Peck and Peckham found that 2 ounces of flour dust diffused with 2 cubic feet of air, when ignited in a box with flame, would produce an explosion sufficient to lift two men standing on the cover. It has been calculated that a sack of flour suspended as dust in 4,000 cubic feet of air (a room 20 by 20 by 10 ft.) when ignited would generate sufficient force to throw 2,500 tons 100 feet high.

Explosions have been produced at the Pittsburgh Testing Station of the Bureau of Mines when there was only .032 ounce of coal dust suspended in each cubic foot of air, or 1 pound in 500 cubic feet. In order to produce combustion it takes all of the oxygen in 1 cubic foot of air to completely burn .123 ounce of the dust used. In France ignition was obtained in one instance with as low a weight as .023 ounce of coal dust per cubic foot, while at the German Testing Station ignitions have been obtained when .04 ounce of coal dust was suspended in 1 cubic foot of air.

Preliminary experiments have shown that many cereal dusts have relatively a lower ignition temperature and produce higher pressures than the coal dusts. We might therefore conclude that the explosive limits would be lower with cereal dusts than the figures given for coal dust.

REMARKABLE CAVE IN COPPER MINE

The Michigan College of Mines has received a beautiful collection of minerals from the celebrated Shattuck Cave, near Bisbee, Arizona, one of the seven wonders of the mining world. This cave was opened in 1913 by a drift on the third level of the Shattuck Mine. When the miner who had been drifting in this part of the level returned one night after a heavy blast, he found that the working face had entirely disappeared and that before him was a great opening reaching farther than his light would shine. Looking upward he could see tiny lights flashing and believing that they were stars he ran back to the shaft, declaring that he had blasted a hole clear through to surface.

Mine officials investigated at once and found that a great natural cavern had been opened up, circular in shape, 340 feet in diameter and 175 feet high. It was a virtual fairyland of beauty, myriads of crystals in the roof reflecting back the lights from the miners' lamps. Walls, roof and floor were covered with great clusters of crystals, and near the center of the cavern a cluster of stalactites hung from the ceiling in the form of a great chandelier 40 feet long. The crystals were for the most part pure white, but in places where the filtering waters had contained iron and copper, the beauty was enhanced by great transparent stalactites and stalagmites, some ruby red, others a clear emerald green or azure blue.

The mining company illuminated the cave with electricity and has allowed thousands of visitors the privilege of seeing it. It is because the mine operators have now found it necessary to fill the cave with waste rock that the Shattuck-Arizona Mining Company sent the specimens to the College of Mines.

ASPHYXIATING GASES IN CIVILIZED WARFARE

Our esteemed contemporary *Le Genie Civil* gives an exceedingly interesting article on the use by the Germans of asphyxiating gases, and of the means which have been taken to render this form of attack harmless. Our contemporary points out that the use of these gases is contrary to Article 23 (*a*) of the Hague Convention, but adds that the enemy had previously and by official command broken the prescriptions of that convention, since in the early months of the war he had not hesitated to employ jets of burning liquid in numerous actions. It appears that the Germans had prepared corps of men specially instructed in the use of these discreditable methods of warfare. But, adds our contemporary, success does not always attend the use of the gases. In one case, at any rate, they were blown back into the trenches whence they had come, and, moreover, they depend, in order to be effectively employed, on the conjunction of several circumstances. But that their use has not had more far-reaching results than is actually the case has been because of the investigations which were immediately commenced by the Belgian, British and French authorities, and which, if they did not reveal the exact nature of the gases employed, have at any rate pointed out the way to combat their ill-effects and very largely to reduce their power of doing damage.

In discussing the nature of the gases used, it is stated that, judging by their properties and the character of their effects, there is not much doubt that the chief constituent is chlorine. It is extremely probable, however, that bromine, formaldehyde, nitric oxide, and sulphur dioxide have also been employed; but apparently chlorine has been used in the greatest bulk. The gases have been discharged against the Allies in several different ways:—(1) By lighting fires in front of the German trenches and burning on them substances which would give off noxious fumes; (2) by letting the gases escape from cylinders in which they were stored under pressure; and in this connection it is stated that the price of liquid chlorine in Germany in ante-war times was from 55f. to 85f. per kilogramme, which represents about 20s. to 30s. per pound, so that some idea of the cost of a gas attack may be formed; (3) by throwing either by hand or by means of catapults glass vessels containing compressed gases; and (4) by hurling from guns a kind of bomb furnished probably with a fuse, which exploded on touching the ground, and let free the gases which had been compressed inside the bomb. It does not appear that up to the present projectiles of this nature have been employed in long range guns. The Germans have made extensive use of the first two methods, and particularly of the second. The cylinders for containing the gases are of steel, about 25 cm. in diameter and from 1.2 m. to 1.35 m. long. They are furnished with a metallic discharge tube 20 mm. in diameter and from 1.6 m. to 1.8 m. long, this pipe or tube being given near its extremity a right-angled bend, so that when the cylinder is placed vertically the bent portion of the tube is horizontal. A cock is placed at the junction of the cylinder and the tube so as to control the mission of the gases, and the weight of the cylinder, pipe, etc., is from 60 kilos. to 65 kilos.—*i. e.*, from 130 lb. to 140 lb.

The Germans are accustomed to arrange these cylinders upright in their trenches, with the bent tubes pointing in the direction of the Allies lines, the tubes just coming above the level of the ground. On the cocks being turned the gases are forced from the tubes and spread themselves over the surface of the ground since their density is greater than that of the air—chlorine being two and a half-time as heavy as air and bromine five times. If the ground slopes away from the German trenches and towards those of the Allies, or if there is a gentle wind from one to the other, the gases roll along much in the same way as does water, filling up all depressions. If the nature of the ground permits of it, the cylinders are arranged in groups of three, four or more at intervals of from 20 m. to 30 m.

In order, however, for the gases emitted by this method to be really successful, a variety of conditions have to be fulfilled. First of all, the wind must be in the right direction, and it must not blow too strongly, or it will dissipate the gases; nor must it change in direction or the gases may get blown back on their senders. Then, again, the air must not be too moist, for the gases are soluble in water and are rapidly thrown down in a condensed form on the ground when the air contains much moisture. It is certainly not to be regretted that it is necessary to have such a conjunction of circumstances, or the gases might be more frequently employed than they are.

The cylinders apparently hold enough to keep on discharging for some twenty minutes at a time. When they are empty they are sent to the rear to be refilled. They are when in the trenches manipulated by special men, who are clothed in a costume very much resembling that of a diver. All the other men in the trenches are provided with masks, which can readily be fixed over the nose and mouth, the masks being provided with cotton pads impregnated with certain salts and with a saline solution which prevents them from getting dry. It is argued that the preparation of the apparatus for producing the gas, the arrangement of the trenches to receive the cylinders, the organization of the service in the rear for refilling the latter, the training of a special corps of men, and the distribution of masks, indicates long and careful preparation, and that premeditation is undoubted, so that the German explanation that the use of gases was in the nature of a reprisal for the alleged use by us of similar gases a day or two before carries no weight whatever. The enemy must have matured his nefarious schemes months beforehand.

Turning, then, to the effects of the gases, the article shows that they were felt 2 kiloms. behind the front line trenches, and the smell could be perceived 5 kiloms. from the point of discharge. In order to cause rapid death it is explained that it is not necessary that the air should contain more than one-thousandth of its volume of chlorine. Even if the proportion is only one in one hundred thousand it is dangerous to breathe the mixture for any length of time. With still smaller proportions the person breathing the atmosphere is sensibly affected.

Two methods of dealing with the gases before they reach our trenches are discussed in the article. The first is that grenades or bombs could be discharged in front of the menaced trenches, these missiles being charged with black powder. These, it is explained, would have two effects:—(1) They would dissipate the cloud of vapours, or at any rate prevent it from being continuous, and would dilute the asphyxiating gases by reason of the gases of explosion; and (2) their discharge would produce potassium sulphate, which would react with the chlorine or some of it and greatly minimize its harmful properties. The reaction is shown in the following equation:—

$$K_2\ S + 2\ Cl = S + 2\ K\ Cl.$$

There is much the same reaction with bromine. The chlorides and bromides formed would be harmless, and sulphur is inert. Or, again, on the approach of the cloud volatile alkalies might be sprayed in front of the trenches. Ammonia is taken as an example. It would have the following reaction:—

$$4\ N\ H_3 + 3\ Cl. = N\ H + 3\ N\ H\ Cl.$$

It is remarked, however, that ammonia gas is itself suffocating and caustic, and would have to be employed with circumspection, while the chlorohydrate of ammonia resulting from the reaction is a solid body which would form a thick, white cloud, which would be a great deal more opaque than the chlorine or bromine gases.

The best preservative against the bad effects of the gases hitherto discovered consists, it is explained, however, in the employment of a respiratory apparatus similar to that served out to the German soldiers. The first appliance used was a mask with a cotton pad impregnated with hyposulphite of soda. The reaction of the chemicals is as follows:—

$$2\ S_2\ O_3\ Na_2 + Cl_2 = Na_2\ S_4\ O_6 + Na\ Cl.$$

Or, if the chlorine be in excess, as is generally the case, the oxidation would be more complete, and sulphuric acid and sodium sulphate produced, thus:—

$$2\ Na_2S_2O_8 + 5\ Cl_2 + 6\ H_2O = 10\ HCl + 2\ Na_2\ SO_4 + H_2SO_4 + S.$$

The hydrochloric acid thus produced is itself a suffocating gas, but it does not produce effects which are in any way comparable with those produced by chlorine. Moreover, the gas would be largely condensed, if not in the wet cotton wool, then, at any rate, in the saliva and would pass to the stomach, which is much better able to resist its effects than are the lungs. If to the hyposulphite were added a small quantity of sodium carbonate, this would also be useful in neutralizing the acids, but then, again, carbon dioxide would be produced.

Quite recently the mask which was always considered unpracticable and not always certain in its action, since it could be so easily knocked off, has been replaced by what is termed a "Cagoule," or monk's cowl, which is a sort of sack worn over the head under the headdress, and which is provided with a horizontal opening closed by a plate of mica, and arranged to come in front of the eyes. The lower part of the sack comes down over the neck, and is buttoned in between the shirt and the vest. The cowl, which before use is steeped in a neutralizing solution, is not found in any way to interfere with respiration nor with the movements of the person wearing it. The chemical reactions take place over the whole of its surface, which is large, the latter fact constituting a great advantage over the mask. The impregnating solution consists not only of hyposulphite and carbonate of soda but also a little glycerine to keep the chemicals moist.—*The Engineer,* London.

The rescue squad of the New York fire department, operating pulmotors, saved lives at a fire that partially destroyed a five-story tenement on April 26. Twenty persons, overcome by smoke, were revived by the use of pulmotors. The fire started in an apartment in the first story and was carried upward through a dumbwaiter shaft.

Nitroglycerin is a powerful heart stimulant; that is why the fumes cause a severe and prolonged headache when inhaled. The same effect is produced by handling dynamite cartridges with bare hands in hot weather.

COMPRESSED AIR COSTS AND SAVINGS IN RAILROAD SHOPS

BY THOMAS F. CRAWFORD.

Twenty years ago when pneumatic tools were in their infancy the installation of an air compressor did not demand the careful study which is now required, because the wonderful saving in time effected by the substitution of air tools for hand tools overshadowed all other costs. Today, however, instead of a luxury to be found in only the best and most progressive shops compressed air is used in every conceivable plant from the two-stall roundhouse on some isolated branch line to the 40-pit main shop at division headquarters.

RAPID COMPRESSED AIR DEVELOPMENT.

A careful study of the growth of the compressed air system in the average shop reveals the fact that the original system has been gradually extended by additions, owing to the many and varied uses to which the high pressure air medium has been applied. The original single stage, 200 or 300 cu. ft. compressor has been replaced by a cross-compound machine of 1,500 cu. ft. capacity; and it in turn has now been supplemented by still more modern and economical compressors with capacities ranging from 3,000 to 5,000 cu. ft. of free air per minute. Steel cars have revolutionized shop practice, and to-day the repair tracks are demanding from 500 to 3,000 cu. ft. of air, where 15 years ago all work was done by hand. This phenomenal development in many cases has bewildered the mechanical department to such an extent that, in spite of the best practice in air compressor construction and installation, enormous losses are daily incurred through improper piping and the lack of study devoted to the very important subject of air distribution.

PROVIDE PROPER PIPING.

The false economy of using the old piping as the system is extended is eating up hundreds of dollars every day in the boiler room and on the switchboard. It is a well known fact that the cost of air varies as the pressure varies; in other words it costs more to compress a cubic foot of air to a pressure of 100 lb., than to 90 lb. Consequently any arrangement of piping which will tend to reduce the initial pressure at the compressor will save money. Assume for example that a shop is piped for a certain size compressor and with the increased requirements the management finds it necessary to purchase a machine of double the capacity. Then, as is often the case, owing to the cost of the machine rigid economy is enforced as to further expenditures, with the result that the important question of piping is neglected. The old piping is considered good enough and only the necessary extensions to the car tracks or other important points are made. No engineering study of the subject has been made and the money saved at one end is going up the stack at the other.

This can readily be seen when a few facts concerning compressed air are considered. In the first place loss of pressure due to friction in pipe lines increases very rapidly as the diameter of the pipe decreases. The pressure loss when transmitting 500 cu. ft. of air per minute through 1,000 ft. of 3½-in. pipe amounts to 1.39 lb., with an initial pressure of 100 lb. per sq. in., while if the pipe size is cut down to 3 in. the loss of pressure jumps to 3.08 lb. Globe valves and fittings such as tees and elbows add greatly to the frictional loss and great care should be given to their application. It will, therefore, be seen that it does not require many poor conditions to build up an unnecessary load on the compressor.

Let us consider a compressor with a capacity of 3,000 cu. ft. of free air per minute operating during a 10-hr. day at approximately 100 lb. pressure and assume that by some rearrangement or replacement of piping the frictional transmission load on this machine is reduced 10 lb. What will the saving be? Under ordinary or even good railroad shop operating conditions it will amount to nearly $3 per day which, in a year of 300 days, would be $900. This represents the interest on an investment of from $10.000 to $15.000, which would go a long way in providing new piping and would pay for considerable engineering study.

Another phase of the subject which offers possibilities for considerable saving is the after-cooling and reheating of the air, particularly where the moisture is excessive and the weather conditions such that long exposed lines are greatly affected. This, however, is a refinement and may be left for investigation after the greater faults are corrected. It is mentioned here simply for the purpose of showing the extent of the field that is awaiting attention.

LEAKAGE.

Pipe and hose leakage presents another source of loss which while appearing small, amounts to many dollars annually in railroad operation. Few master mechanics or shop superintendents realize what a leak signifies in dollars and cents. They know it amounts to something and that it should not exist, but their attention is taken up by things which are of more immediate importance as far as their daily duties are concerned. But when it is realized that for every leak amounting to 1/64 in. in diameter on a 100 lb. pressure line there is a loss of 1.2 cents per day, while for a leak amounting to only 1/16 in. there is the enormous loss of 19.35 cents per day, the subject of leaks assumes some importance. Add up all the leaks from New York to Chicago for instance, on one of our trunk line railroads and it will be found that there is quite a sum of money that is simply vanishing into the air.

In the ordinary railroad shop installation having a capacity of from 1,000 to 5,000 cu. ft. of free air per minute it is fair to assume that it is costing from 2.5 cents to 3 cents per day of 10 hours for every cubic foot of air per minute that is compressed, while in smaller plants where single stage compressors and other old types of machines are used, the cost may be much higher. This is particularly true in roundhouses and small shops using tubular boilers without feed water heaters. With these costs as a basis, another field of economy still greater than those already considered becomes evident. It is the operation and care of pneumatic tools.

PNEUMATIC TOOLS.

Even ten years ago little attention was given to this important subject, and if the tools were lucky enough to get any attention it was probably from some handy man passing out drills and taps from the tool room window. The continuous and almost universal use of pneumatic tools today brings up the question not only of repairs, but of economy of operation Instead of waiting until a motor or hammer is broken down before tagging it for the tool room it should be periodically inspected and repaired, and there should be kept a systematic record of the condition of each tool as well as the cost of its upkeep.

The air consumption of each tool should be studied. No up-to-date shop can afford to keep antiquated tools of obsolete design operating on its floor when it is realized that the cost of air is so great. Even the most modern four-piston air motor consumes from 50 to 60 cu. ft. of air per minute, and when it is considered that through wear or lack of attention it is often consuming 70 or 80 cu. ft., a loss in actual dollars and cents is evident, which will, many times over, pay for the repair parts and labor necessary to place the tool in first class operating condition, or even purchase a new one to replace it.

PNEUMATIC TOOL POWER CONSUMPTION.

In order to emphasize the importance of maintenance, attention is called to the fact that on a full load basis for equal periods the cost of the compressed air required to operate an ordinary 35-lb. pneumatic drill used for such work as staybolt tapping, etc., is from two and one-half to three times as great as the cost of electricity to drive an 18-in. engine lathe.

The standard four-piston type air motor has a crank speed varying from 2,000 to 2,500 revolutions per minute, but as this is geared down at the spindle to a speed suitable for the class of work on which it is to be used the casual observer does not realize the amount of action taking place inside the metal casing. However, it is readily seen that with these little air pistons operating at such high speeds it does not require a great amount of false adjustment or wear to soon result in a large increase in air consumption. With the actual cost of air known, and knowing the cost of the various repair parts, such as pistons, bushings, valves, etc., it is an easy matter to determine the economic high and low limits for every tool and to establish a system by which repairs are made on a basis of air consumption tests rather than under present practice.

The apparatus necessary for testing air consumption and power developed, covering both pneumatic motors and hammers is inexpensive and can be operated if desired by a second or third year apprentice. Data can be kept in such shape that every tool will have its record on file covering both the tests made and the parts replaced. With such a system in operation, if an air motor, the card record of which shows a normal air consumption of 50 cu. ft. per minute, is sent in for test and is found to have a consumption of 60 cu. ft. per minute, on a basis of three cents per day for each cubic foot per minute, it is wasting 30 cents per day, or $9 per month of 30 days. It will not require much calculating to show that regardless of the service which this tool may be giving it should go to the repair bench.

The same idea applies to the various types of hammers, all of which are at times eating up many times their worth when to outward appearances they are in first class condition. With a hammer, however, the waste is not so great, as it is held in the hand in such a manner that the operator becomes extremely sensitive to its operation and can often tell from "the feel" that it is taking too much air. However, the average shopman has never had impressed upon him the great cost of compressed air and his education in the matter by the methods now utilized in safety promotion work would undoubtedly result in eliminating many wastes.—*Railway Age Gazette.*

TESTING A REFRIGERATING SYSTEM WITH AIR

It is customary to test a refrigerating system with air pressure before charging with ammonia. This should be carefully done by experienced men to avoid an explosion by the ignition of the vapor from the lubricating oil, caused by the heat of compression. A thin coating of lard oil should first be applied by hand to the walls of the compressor cylinders and the compressor allowed to run until the pressure reaches 100 lb. or more. It should then be stopped long enough to cool down, then started up again and operated until forty or fifty pounds of additional pressure is obtained, then stopped again. When sufficiently cooled it should once more be started, but at reduced speed, and stopped whenever the discharge pipe becomes hot enough to be uncomfortable to the hand. If these precautions are taken there is little chance of an explosion from internal causes during the test. The men should be kept away from the apparatus as much as possible, however, as there is always a possibility that an accident may occur through the failure of an imperfect joint or from unforeseen weakness in some other part.

The above cautionary advice we reprint from a recent issue of *Power*. When an ammonia compressor is operated with air, and without the precautions here suggested, almost ideal conditions are provided for an explosion, not a mere pressure explosion but one resulting from the ignition of an explosive mixture of air and volatilized hydrocarbon, such as occurs at every driving strike of an automobile engine. The right proportions of oil-gas and air are likely to occur and a temperature may be reached high enough to cause spontaneous ignition.

Such an explosion occurred a few years ago in a large brewery on Third Avenue, N. Y. The piping, about 6 in. and very heavy, was shattered for a hundred feet or more and one or two men, if our recollection is correct, were killed.

AMMONIA EXPLOSIONS IN REFRIGERATING PLANTS

In the preceding article attention is called to the danger of using air for testing purposes in a compressor normally designed and installed for ammonia compression. In the article referred to it is assumed that the danger of explosion comes from the formation of explosive mixtures of air with some volatilized constituents of the lubricating oil; that is, that the presence of vaporized oil in the cylinder and pipes provides the real opportunity and provocation of the explosion.

It would seem, however, from investigations recently reported in a German publication that it may be the ammonia and not the oil that is really the cause. The writer refers to a case of an explosion in a German refrigerating plant, which was ascribed to the decomposition of ammonia in the compressor cylinder and the penetration of the gases into the engine room. This case led to the investigation by the Institute of Physical Chemistry and Electro-chemistry of the Technical High School at Karlsruhe, by S. Schlumberger and W. Piotrowski, who introduced into a bell-shaped glass vessel, 110 mm. (4.33 in.) in diameter, mixtures of ammonia and air in various proportions and ignited them by an electric spark. It was found that a mixture of air with from 16.5 to 26.8 per cent by volume of ammonia violently exploded in the glass vessel, but that with the ammonia content above or below these limits, no explosion took place. Comparative tests with a tube-shaped vessel have given a slower combustion, due probably to the cooling action of the walls, the region of explosibility being limited to from 19 to 25 per cent. by volume.

Refrigerating engineers are, however, interested principally in the question whether conditions such as have been shown by this experiment, and which produce explosibility of ammonia and air mixtures, can actually occur in practice. It is hardly likely that under ordinary conditions, 16 to 20 per cent. by volume of ammonia can mix with the air, but that may, of course, occur in exceptional cases, for example, when a defect develops in the operation of the machinery, a rupture of a pipe occurs, or something like that. In the case referred to above, a branch pipe broke and allowed ammonia to flow out. The fireman, who was burned about the face and hands, claims that he heard an explosion and saw a flame. As there was a gas burner in the engine room, the assumption naturally was that an explosive mixture of ammonia and air took fire from the open flame.

However, the author doubts this, because the conditions under which the actual explosion occurred did not coincide with the conditions which were present when the tests were carried out. In the latter case, ignition was caused by an electric spark, and, because of the shape of the vessel, propagated with considerable velocity. It is by no means proved that an ignition could likewise occur from an open gas flame and that the combustion in free air would occur in the same manner as in a closed experimental bomb. As a matter of fact, the author doubts that there was any explosion at all in this case, in the sense of a sudden combustion of a mixture of gases, and he supports his contention by reference to another accident where ignition of ammonia by a gas flame appears to be fairly well established. According to a report of the German Slaughterhouse Paper (*Deutsche Schlacht- und Viehhofzeitung*, November 15, 1914, p. 574), in November, 1914, there occurred in the engine and boiler room of the Municipal Slaughterhouse, at Elbing, a fire due to a rupture on a compressor and ignition of the escaping ammonia by an open gas lamp. It appears that in this case a screw on the compressor piston worked loose and fell between the piston and cylinder cover so that during the return stroke of the piston the cover was fractured. No explosion occurred, but there was a strong fire, which destroyed the roof of the house.

Mr. A. Behr, in a report to the Sixteenth Annual Meeting of the Association of German Inspection Engineers (Verhandlungen der 16. Hauptversammlung des Vereins Deutscher Revisions-Ingenieure), read a paper on the "Decomposition of Ammonia in Ice Machines," where he mentions a grave accident in the brewery of the Hildesheim Brewery Com- was started with the exit valve in the pressure piping closed. As a result, the cylinder was pany, in which case an ammonia compressor blown up by the increasing pressure. Immediately thereafter, the entire engine room, which was lighted by gas, was enveloped in a sheet of flame. In another case, in a Berlin brewery, rapid ignition took place when a fire was brought near an open ammonia compressor. According to the opinion of Mr. Behr this accident was due not to the combustion of ammonia and air mixture, but to the ignition of hydrogen which formed in the engine through the decomposition of ammonia, which decomposition, in its turn, was due to rise of pressure and temperature of ammonia caused by starting the compressor with a closed pressure valve.

That this decomposition does take place was shown by the experiments of Doctor Mohr, who has found in three instances a high content of free hydrogen and nitrogen in experimental compressors. For practical purposes it would be desirable to carry out a theoretical and experimental investigation which would show whether decomposition of ammonia actually takes place, and if so, how it can be prevented.

KEROSENE AS A FIRE EXTINGUISHER

Fire in bales of cotton at Calexico, California, was recently extinguished by kerosene. While this may seem parodoxical the explanation is simple. Cotton in the baling process is subjected to great pressure. Water can penetrate the bale only an inch or so while kerosene will go to the centre. Fire in the bale does not blaze, simply smolders and slowly cuts its way. At the comparatively low temperature at which cotton burns, and where there is no flame and no air, kerosene does not ignite but instead extinguishes the fire in the cotton. After the fire is put out the bands are removed from the bale, the burned portions are pulled out, and after the cotton has been aired for a few days all trace of the kerosene disappears

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DEATH OF DR. HOLMES

Dr. Joseph Austin Holmes, Director of the Bureau of Mines since its organization under is present form in 1910, died of tuberculosis in Denver, July 12, fifty-five years old, thus by the irony of fate, succumbing to the cruel type of disease against which in the Bureau of Mines his efforts had been so constantly and strenuously employed

Dr. Holmes was born in Laurens, S. C., was educated in local schools and at Chapel Hill, N. C., and graduated from Cornell in 1880. In the following year—his 22nd—he was appointed professor of geology and natural history at the University of North Carolina, remaining in that position for 10 years, and continuing to lecture there several years later. In 1891 he was appointed state geologist of North Carolina, devoting his time for three years to that work, and taking an active part in the preparation of the geological exhibit at the Buffalo Exposition in 1901, which naturally pointed to his selection as head of the Department of Mines and Metallurgy at the St. Louis Exposition in 1904.

In this year his first active work for the government began when he was placed in charge of important fuel tests. In 1905 the director of the United States Geological Survey extended his work to cover mine explosions and other phases of mine work. In 1907 he was made chief of the technologic branch of the Geological Survey, holding that position until the Bureau of Mines was formally established by act of Congress in 1910.

There were several qualified candidates considered for the position of head of the new bureau, but when Dr. Holmes was finally appointed universal approbation greeted him and the record of the bureau under his direction and stimulus has surpassed all expectation.

The following is the editorial tribute of the *Engineering and Mining Journal*:

The Bureau of Mines became his child. He practically created it, organized it and laid out its course. There is scarcely anything in it whereof the inception is not owed to him. He was ambitious for it and sometimes was criticized for the vaulting character of his ambition, although all recognized that there was never in his mind a thought of personal aggrandizement, but only and always of the prestige and public usefulness of his institution. For it he worked every hour of the day except when sleeping, traveling thousands of miles annually, enduring the hardships of railway tedium, poor food and miserable hotels, and holding intercourse with thousands of persons. The ability to get on well with people was one of his happy faculties, as also was his art of surrounding himself with able and loyal assistants. He was never willing, however, to relieve himself of arduous duties by delegating them to his assistants. Their function in his mind, was solely to enable his bureau to do more work, and he devoted himself indefatigably to finding it for them to do. He made the Bureau of Mines a great thing in remarkably few years, but in doing it he killed himself, leaving the mining and metallurgical industries of his country his eternal debtors. His special interest was the promotion of safety in mining. With keen perception he singled out the correction of the disgracefully high mortality in American mining as being the first big work that the Bureau ought to do."

Dr. Holmes received the degree of D.Sc. from the University of Pittsburgh and that of LL.D. from the University of North Carolina. He was a member of the Mining Legislation Commission of Illinois, National Conservation Commission, American Institute of Mining Engineers, American Society for Testing Materials, the Academies of Science of St. Louis and North Carolina, American Society of Mechanical Engineers, the Cosmos Club of Washington, the Engineers Club of New York, and was a fellow of the Geological Society of America.

COMPRESSED AIR IN THE SMITHY

The article 'Electrifying the Forge Shop" in the July issue of COMPRESSED AIR MAGAZINE reminds the writer of similar work that was done in the Argentine Republic in 1905, in the new workshops of the Buenos Aires Western Railway Co. When this Company built their new shops they made liberal allowance for the use of compressed air all through the different departments, and also contemplated working the steam hammers in the smith shop by compressed air; but as this was a new venture at that time they were not sure whether it would be a sucess. However, all precautions were taken; large receivers were hung from the roof trusses close to the hammers, and Ingersoll reheaters were provided so as to economize air as much as possible.

This being an untried experiment it was not known whether the air compressing plant would prove sufficient, as a very complete equipment of pneumatic tools had been provided, and the foundry was equipped with molding machines and sand sifters. There were in the Power House two JC compressors with two stage air cylinders 16¼" & 10¼" by 10" driven by 60 H. P. electric motors. The Smith shop had one large steam hammer and two small ones and steam boilers were provided in case their operation by air was not a success. The hammers were run by steam for some time, as the air receivers and piping were not ready, but after being tried out by air their operation was found to be thoroughly satisfactory, and the air compressing plant ample to do the work, together with driving all the pneumatic tools and molding machines in the foundry.

It would be quite impossible to give any idea of the comparative cost of operation by steam and by air, as their work was so intermittent; but it was considered that operation by air was most satisfactory. To run the hammers by steam required a large boiler to be kept constantly under steam, which consumed about a ton of coal a day, costing $10, besides the wages of a fireman and the smoke nuisance. We could not arrive at the amount of extra air required owing to the impossibility of isolating the hammers from the remainder of the pneumatic tools and operating them separately by a compressor; but it seemed to every one, that, not only was it much cheaper to drive them by air, but that their operation was in every way more satisfactory. The hammers worked quicker, were free from condensation, there was no dripping water, nor hot parts to inconvenience and burn the workmen.

J. P. STONE,
104 Madison Ave., N. Y. City.

The chemists of the United States Bureau of Mines have discovered a process whereby radium can be produced at one-third its present cost: or at a price of $40,000 per gram ($1,134,000 per oz., Avoirdupois) instead of $120,000.

EXPLOSIONS IN AIR LIQUEFACTION PLANTS*

There have been several disastrous explosions in plants manufacturing oxygen and nitrogen from liquid air. As a rule, it is quite possible to separate oxygen and nitrogen by fractional distillation in the so-called countercurrent apparatus, but it appears, however, that these apparatus are sometimes subject to highly dangerous occurrences.

The pipes of the column apparatus in which the oxygen is separated from the liquid air have to be thawed out at night because of accumulation of ice. This thawing out process is usually carried out with warm water and, in the meanwhile, the operation of the plant is interrupted. In one case, the attendant was busy thawing out the pipes while a laborer was removing the insulating cork. The foreman had most strictly prohibited the use of a torch, but notwithstanding that the attendant did use one, as he was seen carrying the torch inside. Immediately thereafter, there occurred an explosion which threw aside heavy iron beams, blew up the roof, killed the attendant and did a lot of other damage. The explosion was followed by a fire. It seems reasonable to believe that the attendant approached with his torch too close to the insulating cork of the column apparatus and in this way ignited the mass. Whether the explosion was due directly to the explosive combustion of the cork or was accompanied by the explosion of illuminating gas has not been established. Tests have shown, however, that the extremely porous cork used in this kind of apparatus accumulates in a very short time such large amounts of oxygen in its pores that it becomes highly explosive.

Another explosion which likewise occurred in an air liquefying plant is also of great interest. It occurred in a plant manufacturing from liquid air pure nitrogen to be used for the production of calcium nitrate. In this case the separation apparatus exploded, mortally wounding the foreman. In this apparatus, the air was compressed to four atmospheres, and was thence led to the liquefaction system where it was allowed to trickle in a column apparatus 3 m. high. The nitrogen evaporated while the oxygen collected in two vessels connected by an overflow. In order to free the nitrogen from the last traces of oxygen, a part of the nitrogen compressed to 100 atmospheres flowed in a thin spiral through the countercurrent helix and through the collector filled with liquid air or oxygen, whence it flowed freely into the upper part of the column While this was done, the last traces of the oxygen contained in the nitrogen were liquified and flowed down into the collector, and this, as well as the column, was equipped with a safety valve which prevented the pressure therein from exceeding 0.5 atmospheres

The explosion, which caused a large amount of damage, was not due to excessive pressure, as the presence of a safety valve protected it from that. Two separate detonations appear to have been heard and it seems that the collector was the first to be destroyed, whereupon the oxygen flowing out produced an explosive combustion of the insulating silk. After the first detonation, the foreman rushed to the apparatus but was thrown back by the second explosion, and hurled against a compressor. Previous to that another explosion of a similar nature had taken place, which was ascribed to the fact that in some manner or other the air taken in contained traces of acetylene and that copper acetylide, which is highly explosive, was formed. It does not appear likely, however, that copper acetylide would decompose explosively at a temperature as low as that of boiling liquid air.

The author describes a third explosion which destroyed an enitre factory and caused a heavy loss of life. The persons who were in the factory saw a bluish flame, similar to that of lightning, start from the ground. Then a big gray cloud of dust was seen and finally a tremendous detonation was heard, after which the building practically collapsed. Some of the bodies recovered from the ruins were found to be terribly mutilated. The separation apparatus had entirely disappeared and there was an immense hole in the wall near which it stood. From the testimony of the workmen who were in the factory just previous to the explosion, the following is what apparently occurred: The chief engineer and his assistant had started the plant in the morning and it appeared to be working all right. They forgot, however, to blow off the dew which accumulated in the apparatus after it had been standing idle over Sunday and had become somewhat warm. Notwithstanding the most careful cleansing of the air previous to its admission into the liquefaction system, a certain amount of water settled down as ice in the separation apparatus; this had to be melted and removed from time to time. A couple of hours after the plant was started, the foreman inspected it and found everything in order, but apparently the apparatus had simply frozen. When the engineer, who was working the apparatus alone, did not know what to do, he went to the superintendent and was ordered by him to thaw out the apparatus, the superintendent then withdrawing to take care of his clerical work. The engineer, however, notwithstanding strict orders not to bring any fire or hot objects near the apparatus, heated, by a torch, up to red heat, a large wrench used for tightening the stuffing boxes of the expansion valves, and put it into the expansion valve when the insulation of the apparatus apparently caught fire.

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*A. S. M. E. Journal abstract from the German.

Some other cases of explosions in air liquefaction plants are likewise described. From all these, it appears that the causes of explosions may be divided into two classes—one, which is obvious, produced by the prohibited use of an open flame, and the other, less obvious, due probably to some sort of chemical action or freezing.

The author calls attention to the following facts as serving as possible explanations of explosions of the second class. Essentially, air consists of a chemical mixture of oxygen and nitrogen, in addition to which there are present in it, water vapor, carbon dioxide, complex gases and the so-called noble gases, such as argon, metargon, helium, xenon, neon, and krypton. The essential properties of these noble gases are that they apparently do not enter into any chemical combination either among themselves or with other gases. The most important of them is argon, of which there is present in the air approximately 0.935 per cent by volume. It liquefies at — 186 deg. cent.; oxygen at — 184 deg. cent. and nitrogen at — 194 deg. cent. In apparatus where nitrogen is produced and where, therefore, a very low temperature has to be maintained, it is quite possible that argon settles down in the pipes, forms an ice-like mass and in this way bottles up the air passages, thus raising the compression of the gas up to the point where it explodes the apparatus.

It is also possible that argon brings about explosions in another manner. Essentially, the noble gases have not a molecular, but an atomic structure; that is, they consist of single atoms. It is, however, possible that this structural property changes at very low temperatures, and in the argon ice the atoms of the gas combine into a complex gas, which dissociates explosively when the temperature rises. Similar explosive dissociations may also take place in the case of peroxide of hydrogen and ozone.

Another source of danger which may cause explosions is the presence of combustible substances in the liquefied air, due, for example, to the penetration of oil from the compressors or perhaps of products of decomposition of lubricating oil formed in the compressors under the influence of the heat of compression. It is also well to bear in mind that in the atmospheric air there are present small amounts of hydrogen and methane, and it is quite possible that if both gases are present in equal amounts they may, after a certain length of time, appear in quite substantial quantities in liquefied air. Considering that air liquefaction plants have usually an output of 400 cu. m. (14,125 cu. ft.) per hour, or 4,000 cu. m. per working day of 10 hr., and considering further that there may quite easily be 0.05 per mil of methane, this would be equivalent to 200 l. (52.8 gallons) of liquid methane, an amount sufficient to create a tremendous explosion in the presence of liquid air or oxygen.

There is one more fact which has to be borne in mind. Ozone may convert hydrocarbons into highly explosive compounds—so-called ozonides or peroxides. Harries produced such explosive compounds even from hydrocarbons having annular formation, such as benzole and toluol, and from other derivatives of methane. Saturated hydrocarbons, such as methane, produce explosive substances of the peroxide type and can be converted into formaldehyde and formic acid. From methane derivatives are also produced ozonides proper, which in most cases are highly explosive, and in the presence of water dissociate into aldehydes and peroxide of hydrogen. Unsaturated ketons, aldehydes and single-base acids of fats combine with four atoms of oxygen thereby also forming explosive compounds. It appears, therefore, that unless extreme care is exercised, there are numerous sources of danger in the production of liquid air and its component gases.

GAS FOR INDUSTRIAL PURPOSES

The use of gas for industrial purposes is rapidly increasing, particularly where a supply of a cheap by-product gas is available. But coal gas supplied by town companies is also progressing in the same direction, and is making up by its convenience, and by a number of smaller economies which are possible with its use for its higher cost as compared with coke or coal. In order to let London manufacturers see what can be done and to encourage the consumption of gas in its own area, the Gas Light and Coke Company has opened a large demonstration building in its depot at 146, Goswell-road. At one end of this building is an engine-house, where a small gas engine drives a compressor, raising gas to what is known as high pressure—about 100 in. of water—whilst a fan provides air also at "high pressure." In this room are also to be found meters for measuring the gas supplied at and above atmospheric pressure. The different pipes leading from the engine-room are painted in distinctive colours according as they convey gas at atmospheric or at high pressure, or high-pressure air. In the body of the building is arranged a representative collection of gas-heated industrial furnaces and appliances of all kinds; there are furnaces for heating and tempering tools, furnaces for melting metals of various kinds either for foundries or printing houses, etc., furnaces for enameling, a salt bath furnace, muffles of various forms and sizes, burners for sugar boiling, and burners for heating soldering irons, blow pipes, etc. This very representative exhibition has been provided by several firms. Some of the burners use both gas and air at atmospheric pressure; others use both at high pressures, and others one or the other only at high pressure.—*The Engineer,* London.

WELLS MORE THAN A MILE DEEP

The deepest well in the world is in Upper Silesia, in the German Empire. It is a diamond-drill hole in a coal field and is 7,350 feet deep. A well in the United States which may go deeper, according to the United States Geological Survey, is 4 miles northwest of McDonald, Pa., and about 15 miles west of Pittsburgh. This well, which is being sunk to the Medino sandstone—a bed that elsewhere contains oil and gas—is now 7,174 feet deep. Some gas and oil were struck in the upper part of the well. Between the depths of 6,830 and 7,100 feet rocks bearing rock salt and salt water were encountered. These are regarded as of Salina age, the same as those carrying rock salt in western New York. The temperature in this well at the depth of 6,775 feet, as recently determined with great accuracy, is 145.8 degrees F.

At Derrick City, McKean County, Pa., near Bradford, there is a well 5,820 feet deep, which is probably the second deepest well in the United States. Another deep well is on Slaughter Creek, Kanawha county, W. Va.; it is 5,595 feet deep. It penetrated a sandstone at 5,030 to 5,050 feet, and from this depth to the bottom, a distance of 545 feet, the well is in limestone. Near West Elizabeth, Pa., there is another well 5,575 feet beneath the surface, penetrating into a blackshale. Another deep well is being drilled at Gaines, Pa. This has already reached a depth of 5,500 feet. Deep-well drillers in this country of course employ the most improved and effective rigs, but one of the most remarkable of wells, reaching a depth of 3,600 feet, was drilled for petroleum in western China by means of such crude appliances as a cable made of twisted strands of rattan.

GRANITE NOT THE OLDEST OF ROCKS

It used to be thought that granite was the oldest of all rocks and that it formed the globe's first crust. Now, however, geologists believe that granite may be of any age or epoch. The granites found in Germany and the Vosges Mountains, of France, date from one period of the world's history; those found in the British Isles, from an entirely different period; and those found in the United States from still other periods.

Enormous pressure, combined with heat and water, must have been necessary to produce granite. Some scientists declare that the granites in the Highlands of Scotland must have been formed when 60,000 feet of overlying rocks were piled above them, and that those of Cornwall required 40,000 feet of rock pressure.

NOTES

The pneumatic method of placing concrete was used successfully for conveying the mix 2805 ft. through a 6-in. pipe on the Mile Rock tunnel work at San Francisco. The compressor capacity installed was 1,200 cu. ft. per minute, and the receiver pressure was kept at about 115 lb. per square inch. This is regarded as a record for long-distance work of this character.

The British height flying record, which stood at 14,500 ft., was beaten at the Hendon Aerodrome on Sunday last, June 6th, when Mr. Hawker, on a new type Sopwith biplane, reached an altitude of over 20,000 ft., nearly four miles. Although it was a perfectly clear day, the pilot actually disappeared from sight and could only be discerned through powerful glasses.

Hydrogen was discovered or isolated in 1766 by Cavendish, an eccentric English chemist, who called it "inflammable air," but the French chemist, Lavoisier, named it hydrogen, meaning "water former." Nitrogen was also identified as a constituent of air at about the same date as oxygen and hydrogen (1766 to 1774) and named nitrogen by Chaptal, because of its existence in niter.

An exhibit at the San Francisco Exposition, illustrates the variety of uses which science has found for soft coal. An enormous block of coal is shown surrounded by its products. The first "generation" consists of ammonia, illuminating gas, crude benzol, coal tar, and coke. The derivatives of each of these substances are in turn grouped around it. Coal tar, for instance, is the parent of Tarvia and other bituminous road binders, numerous ready-roofings, creosote oil, etc.

Do not fool with compressed air, as it is dangerous if handled carelessly. Never blow it on anyone, as it may enter his body and injure or kill him.—*American Machinist.*

This is nonsense, neighbor. They blow compressed air onto you in the barber shop. They can't blow it into you any more than they can blow steam into you, and air won't scald. Nothing is safe if used without common sense, and with common sense nothing is safer than compressed air.

Plans for the ventilation of the new subway lines in New York are to be considered by a board of engineers. The present plan is to ventilate by means of open gratings on the sidewalks, which plan is opposed by the merchants on the ground that the gratings are avoided by pedestrians and they thus will look less into the store windows, which is more or less true. Single tubes with the trains acting as pistons would secure a constant change of air.

The sixteen inch gun built at Watervliet Arsenal more than ten years ago, the only gun of this calibre built by the United States, has been taken to Panama Canal where it will have a disappearing mounting costing much more than the gun, and its effective life may be expected to be ended when about 100 shots have been fired. A number of fourteen inch guns will be placed at Panama, these costing $45,000 each and their carriages $85,000. The cost of a powder charge for one of these is $175 and of the projectile about $500.

Tests have shown that moist acetylene, as generated, attacked zinc, lead, brass and nickel to a slight extent; iron was affected at about six to seven times the rate; phosphor bronze about twice as much as iron; but copper suffered more than any other metal tested. Copper was quickly changed into a soft, porous black mass. Tin, aluminium, bronze, German silver, and solder were practically unaffected. Thus it would appear that copper and brass or other copper alloys should not be used as piping for acetylene gas supplies, and that iron should be well tinned rather than galvanized or nickel-plated.

The principal use for tungsten is in the manufacture of high-speed steel, which holds its temper at much higher temperatures than does carbon steel. There are many applications for ductile tungsten; the ductile metal is practically insoluble in all of the common acids, its melting-point is higher than that of any other metal, its tensile strength exceeds that of iron and nickel, it is paramagnetic, it can be drawn down to smaller sizes than any other metal, while its specific gravity is 70 per cent. higher than that of lead. One important use of ductile tungsten is that large quantities of drawn wire are produced, both flexible and strong, for the manufacture of incandescent lamps.

Some arbitrarily coined trade words, such as kodak, find a permanent place in the dictionary. Another respectable class of trade words, not one of which, so far as we know, has as yet reached the dictionary, are those formed of the initials of a manufacturing company with the syllable "co" added, a good example of which is the "Mesco" of the Manhattan Electrical Supply Co.; but perhaps the simplest of all is the "Irco" of the Ingersoll-Rand Company. Kodak serves as both a noun and a verb; but Irco is also an adjective descriptive of a superior metal for rock drills and mining apparatus.

The first American exposition of chemical industries will be held at Grand Central Palace, New York City, during the week beginning Sept. 20, 1915. It is to be managed by C. F. Roth and A. Nagelvoort, assisted by an advisory committee of nine eminent chemical engineers. It is expected to include coal, wood and petroleum products, metals, minerals, water and sewage purification, air and gas processes, glass and ceramics, oils, varnishes, plastics, rubber, leather, glue, etc. Working exhibits will be shown. Inquiries should be directed to the National Exposition of Chemical Industries, 46th St. and Lexington Ave., New York City.

The use of poisonous gas by the Germans in the French trenches suggests some great possibilities for the defensive as well as the offensive. The *Bystander*, a British publication, says that the device has surely come to stay though properly enough denounced as a violation of the present laws of warfare. No Hague Conventions are likely to abolish it—if there are any more such ridiculous things as Hague Conventions. One foresees that instead of fortresses henceforward each country will line its frontier with gas jets, which, being invisible and their works subterranean, will be indestructible. The knowledge that his landing on these shores, if effected at all, will be greeted by blasts of his own poison-gas, made as noxious as chemistry can make it, will digress the enemy's ardor somewhat

Our contemporary has forgotten that it will be quite possible to supply masks or helmets connected to reservoirs containing air either compressed or liquefied

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

The following official notice from the Commissioner of Patents will sufficiently explain any break in our regular weekly report of patents issued.

Department of the Interior,
United States Patent Office,
Washington, D. C., June 10, 1915

On account of the unusually large number of patents issued during the current fiscal year the regular appropriation of $440,000 for printing specifications and the Official Gazette and a supplemental appropriation of $125,000 have been nearly exhausted. It will not be possible to issue the Gazette for June 15, 22 and 29 on these dates. These issues will be sent out as early in July as the publication thereof can be brought about. Owing to the resulting congestion there probably will be some delay in the issues of the Gazette for July until conditions in the office of the Public Printer again become normal. There will be no delay in the issuance of patents, designs, or trade-marks.

THOMAS EWING.
Commissioner of Patents

JUNE 1.

1,141,109. ELECTROPNEUMATIC BRAKE FOR RAILWAY-CARS. James S. Doyle, New York, N. Y.

1,141,114. CONTROLLER FOR FLUID-PRESSURE-ACTUATED DEVICES. Clark T. Henderson, Milwaukee, Wis.

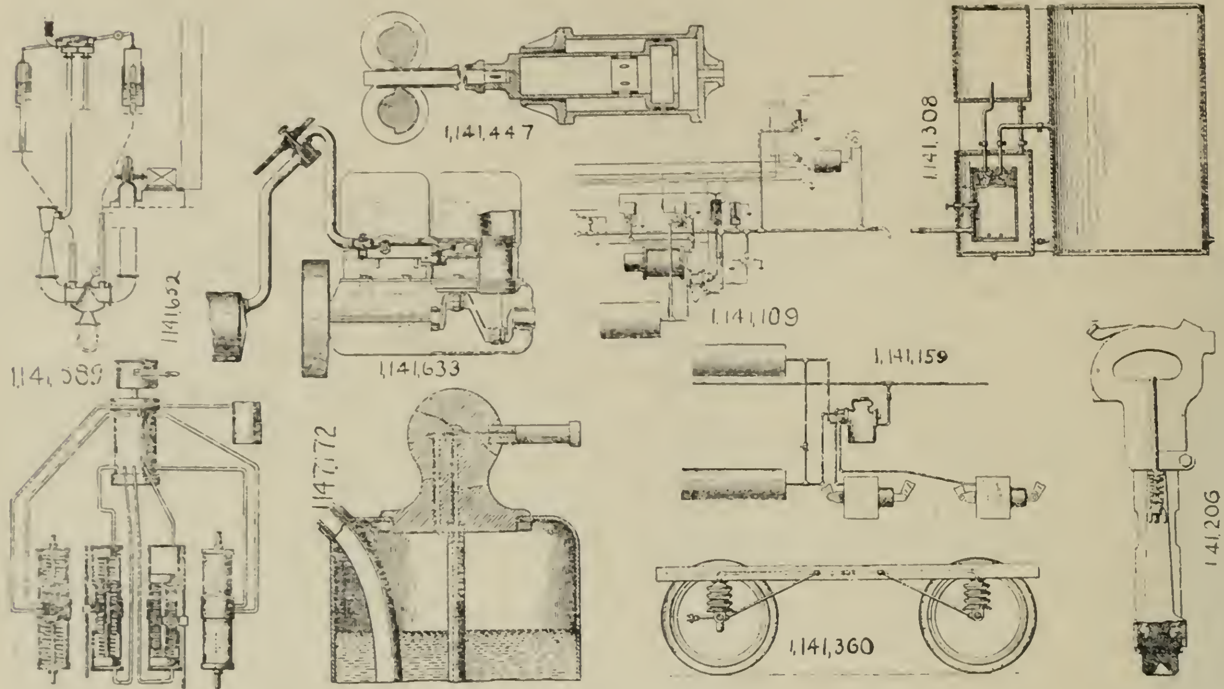
1,141,159. CONTROL-VALVE DEVICE FOR FLUID-PRESSURE BRAKES. Walter V. Turner, Edgewood, Pa.

1,141,206. CLUTCH FOR A PNEUMATIC HAMMER. Samuel Oldham, Philadelphia, Pa.

1,141,236. UNIVERSAL AIR-BLAST. Jacob Diehl, Glenbeulah, Wis.

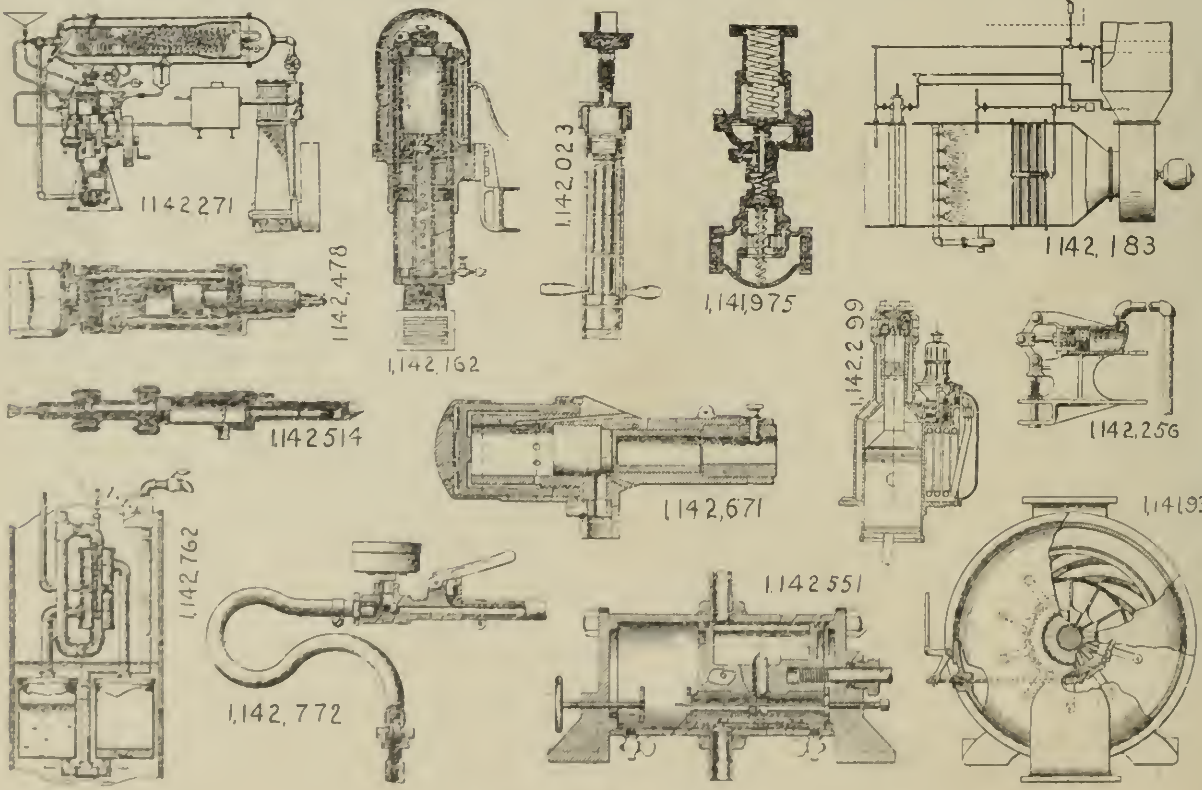
1,141,308. POWER-GENERATOR. George Boltz, Amy, Kans.

The combination with a tank for compressed air, a reservoir for a hydrocarbon fluid, a water tank and a generating chamber arranged spaced apart within the water tank, of a body of asbestos arranged at one end of the generating chamber, a grate member extending transversely of the generating chamber and confining the as-



Pneumatic Patents June 1.

bestos at the end of such chamber, a valved spray pipe extending through the water tank and into the generating chamber in the front of the grate, said spray pipe having a lateral port therein through which the water in the water tank may pass, said water being admitted to the generating chamber in the form of a spray, a pipe leading from the hydrocarbon reservoir to the asbestos body to supply hydrocarbon fluid thereto, a valved pipe for conducting air under pressure to the reservoir to force the hydrocarbon fluid therefrom into the generating chamber, a valved pipe for conducting air from the compressed air tank to the generating chamber where it is mixed with the hydrocarbon fluid at the asbestos body within the generating chamber, a valved pipe for conducting air to the water tank to force the water into the generating chamber, and a valved pipe for conducting the steam and heated gases generated in the generating chamber to the point of use.



Pneumatic Patents June 8.

1,141,360. PNEUMATIC CUSHION. Herbert F. Rudd, Belpre, Kans.

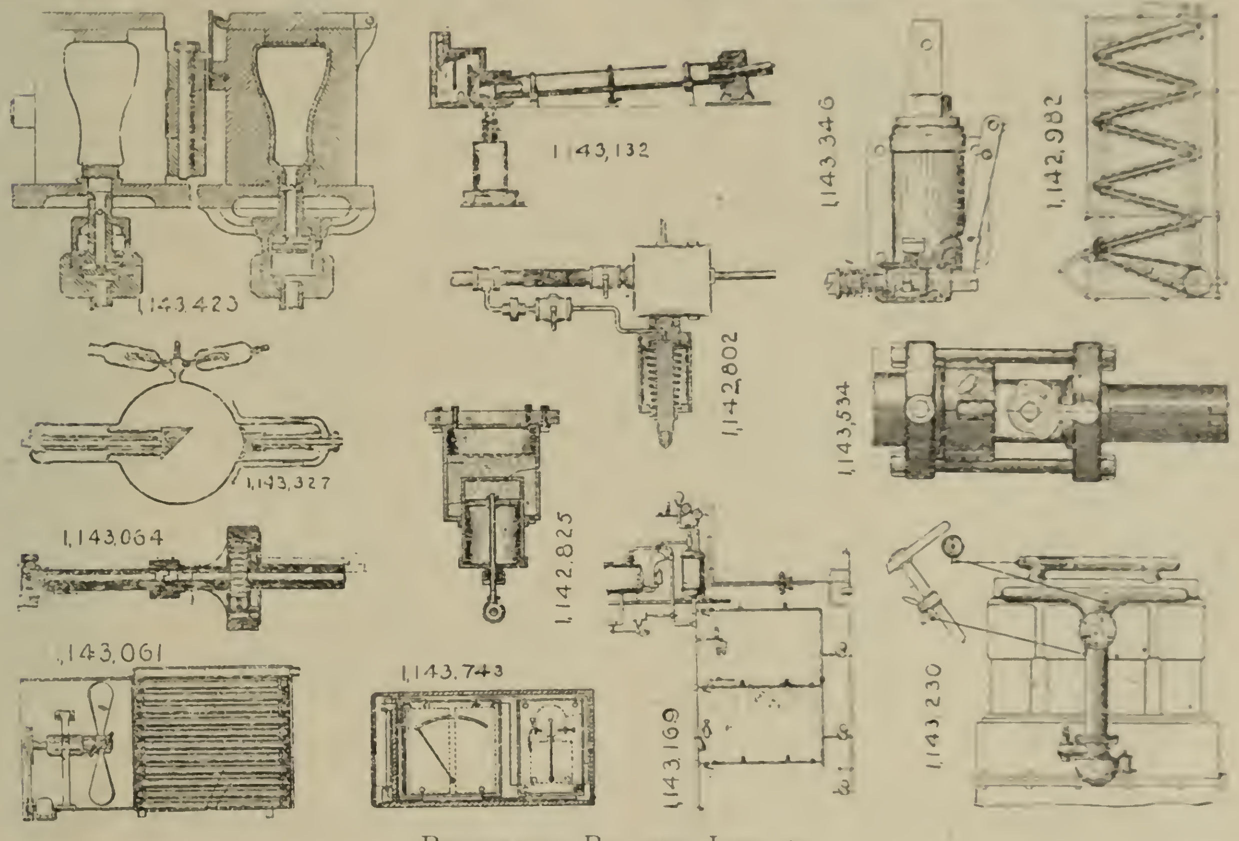
1,141,379. PNEUMATIC ACTION FOR AUTOMATIC PLAYERS. Melville Clark, Chicago, Ill.

1,141,447. ROLLING-MACHINE. Oscar Dellwitz, Tegel, near Berlin, Germany.

1. In a pilgering mill, the combination comprising a cylinder adapted to be supplied with a compressed fluid, a piston mounted within said cylinder and adapted to leave a hollow space between a portion of said piston and the forward end of the cylinder, said piston having means of communication with the hollow space and being adapted in its movement to close said means of communication so as to form a cushion, and a mandrel mounted in said piston.

1,141,589. FLUID-PRESSURE AUTOMOBILE CONTROL MECHANISM. Nicholas Taylor, Muskogee, Okla.

1,141,597. VACUUM-CLEANER. Morris S. Wright, Worcester, Mass.



Pneumatic Patents June 15.

1,141,621. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. Lewis B. Doman, Elbridge, N. Y.

1,141,633. SELF-STARTING INTERNAL-COMBUSTION ENGINE. John Allen Heany, Washington, D. C.

1,141,650. JACK HAMMER-DRILL. Samuel Oldham, Philadelphia, Pa.

1,141,652. BLOWING SYSTEM FOR FURNACES. Heinrich Poetter, Dusseldorf, Germany.

1,141,721. ATOMIZER. James G. Mastin, Chicago, Ill.

JUNE 8.

1,141,938. AIR-REGULATING DEVICE FOR CENTRIFUGAL COMPRESSORS. Clarence P. Crissey, East Orange, N. J.

1,141,939. AIR-BRAKE FOR MOTOR-CARS. Irvin Crum, Selma, Ala.

1,141,948. PRODUCTION OF AMMONIA. Fredrik W. de Jahn, New York, N. Y.

The herein described process of producing ammonia, which comprises suitably passing a gaseous mixture containing nitrogen and hydrogen under a pressure less than 100 atmospheres in contact with a heated catalytic agent containing (1) cobalt, (2) sodium and (3) nitrogen.

1,141,975. PNEUMATIC CONTROLLER. John L. Osborne, Rochester, N. Y.

1,142,023. SUCTION APPARATUS FOR DENTAL CASTING APPARATUS. Edward L. Chott, Chicago, Ill.

1,142,162. FLUID-PRESSURE CUSHIONING AND WEIGHING MECHANISM. Lucien R. Gruss, San Francisco, Cal.

1,142,271. METHOD AND MEANS FOR THE GENERATION OF COMPOUND MOTIVE FLUID. Bennett L. Rinehart, Philadelphia, Pa.

1,142,299. COMPRESSOR. Walter W. Brown, Erie, Pa.

1,142,478. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,142,483. METHOD OF HUMIDIFYING AIR. William G. R. Braemer and Samuel C. Bloom, Camden, N. J.

1,142,514. PULSATOR-DRIVEN PERCUSSIVE TOOL. Arthur H. Gibson, Easton, Pa.

1,142,551. FLUID-PRESSURE MOTOR. George W. Burnhart, Denver, Colo.

1,142,671. PNEUMATIC TOOL. Benjamin M. Carmina, New York, N. Y.

1,142,762. DEVICE FOR ELEVATING FLUIDS. William J. McGuire, Kewanee, Ill.

1,142,772. AIR-GAGE APPLIANCE. Carl E. L. Lipman, Beloit, Wis.

JUNE 15.

1,142,802. DRILLING AND BORING MACHINE. Joseph L. Didier, Salisbury, N. C.

1,142,825. SHOCK-ABSORBER. William F. Lyons, Kansas City, Mo.

1,142,827. PROJECTILE FOR AIR VESSELS. Richard Machenbach, Schlebusch, near Cologne, Germany.

1,142,860. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,142,982. MEANS FOR CLEANING AIR. Harvey J. Richardson, Chicago, Ill.

1,143,061. DEHUMIDIZER. Glen O'Brien, Manhattan, Kans.

1,143,064. PNEUMATIC TURBINE-GRINDER. Charles Perkins, Bridgewater, Mass.

1,143,132. PROCESS OF FIXING ATMOSPHERIC NITROGEN. SAMUEL PEACOCK, Chicago, Ill.

1. The method of fixing atmospheric nitrogen in fuel fed furnaces, which consists in providing a suitable furnace charge of carbon and an oxid the carbon being in such excess as to preclude the formation of carbon dioxid during the process; and feeding free nitrogen, air and fuel to said furnace and thereby subjecting said charge to a temperature sufficient to fix the said free nitrogen, as well as some of the nitrogen left in said air after the oxygen has been consumed, substantially as described.

1,143,169. FIRE-EXTINGUISHING APPARATUS. EDWARD R. BRODTON, Washington, D. C.

1,143,230. AIR-CONTROLLED DEVICE FOR GAS-ENGINES. WILLIAM A. ROOT, Bennington, Vt.

1,143,677. BLOWPIPE. MILTON E. WINANS, Newark, N. J.

1,143,708. APPARATUS FOR SEPARATING SHEETS FROM A PILE OR STACK. JACOB HEINRICH, Nuremberg, Germany.

1,143,833. VACUUM-CLEANER. WILLIAM H. KELLER, Philadelphia, Pa.

1,143,923. CRUDE-OIL BURNER. EDWARD D. VARNUM, San Diego, Cal.

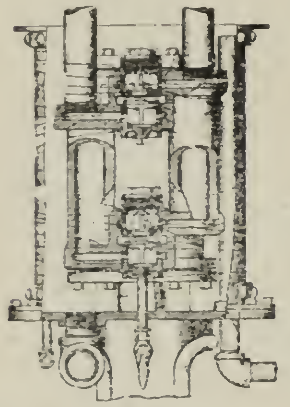
1,143,962. AIR-MOISTENER. CLARENCE B. HAYNES, Camden, N. J.

1,144,203. PNEUMATICALLY - OPERATED WINDOW-CLEANER. FREDERIC WILLIAM HOGG, The Dalles, Oreg.

1,144,297. RIVETING-MACHINE. MANLEY J. CHAPLIN, Seattle, Wash.

JUNE 29.

1,144,342. AIR-LIFT FOR ELEVATING LIQUIDS. BENJAMIN ANDREWS, Houston, Tex.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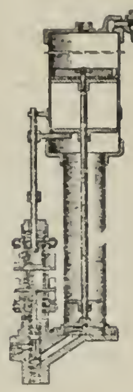
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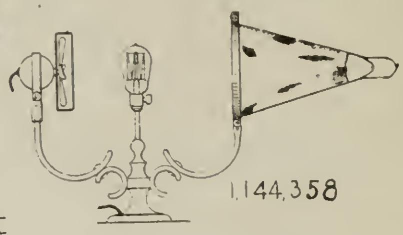
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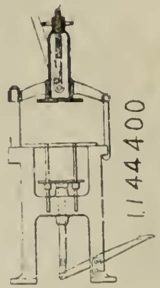
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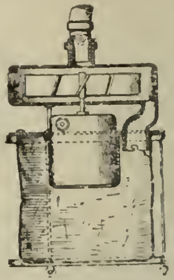
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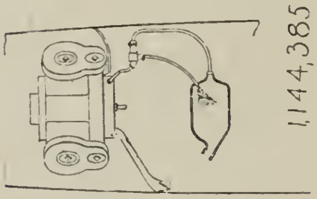
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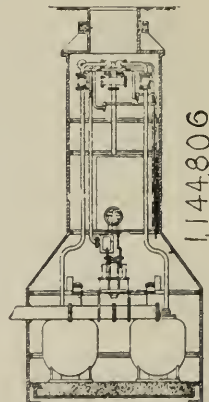
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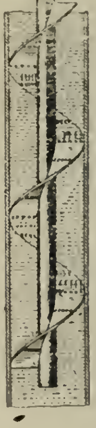
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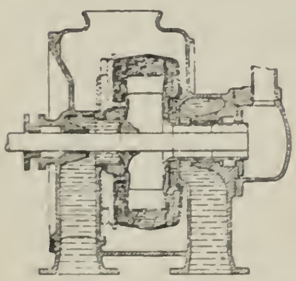
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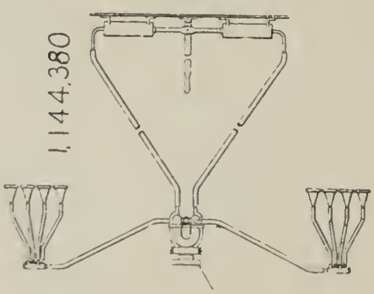

1,144,380

PNEUMATIC PATENTS JUNE 29.

1,143,327. VACUUM REGULATION. HOMER CLYDE SNOOK, Cynwyd, and EDWIN W. KELLY, Philadelphia, Pa.

1,143,346. PNEUMATIC TRIP. ARCHIE M. BAIRD and HARVEY D. PALMER, Topeka, Kans.

1,143,423. GLASS-MOLDING APPARATUS. FRED C. MESSNER and JOHN WILLIAM LAMPARTER, Moundsville, W. Va.

1,143,473-4. CONTRIVANCE FOR AUTOMATICALLY DETECTING THE PRESENCE OF CERTAIN GASES AND VAPORS. ALFRED WILLIAMS and LEO DAFT WILLIAMS, London, England.

1. An apparatus for detecting, by electrical manifestations, the presence of combustible gases in the atmosphere, comprising a casing having an open and a sealed compartment, a pair of thermo-electric elements in the open compartment, a catalytic element in one of said thermo-electric elements, and a circuit for said thermo-electric elements, a voltmeter and a relay inserted in said circuit and situated in the sealed compartment, and means for maintaining said thermo-electric elements at an even heat.

1,143,533-4. PRESSURE-ACTUATED TOOL. GEORGE H. GILMAN, Claremont, N. H.

JUNE 22.

1,143,620. TRIPLE-VALVE-TESTING APPARATUS. CLYDE C. FARMER, Chicago, Ill.

1,144,358. INSECT-CAPTURING APPARATUS. KNUT GEORGE GYLLSTROM, Richmond Hill, N. Y.

1,144,360. VALVE MECHANISM FOR GAS-COMPRESSORS. HENRY W. JACOBS and HOWARD H. LANNING, Topeka, Kans.

1,144,380. COW-MILKING MACHINE. ALBERT VICTOR RACKSTRAW, Bedford, Ohio.

1,144,385. DEVICE FOR THE INJECTION OF WATER AT HIGH PRESSURE INTO THE AIR-REHEATERS OF TORPEDO-ENGINES. EUGENE SCHNEIDER, Le Creuzot, France.

1,144,400. HAND MOLDING-MACHINE WITH LIFTING ARRANGEMENT. ANTOINE UTARD, Longeville, France.

1,144,641. COMPRESSOR-PUMP. EDWARD W. COMFORT, Winchester, Mass.

1,144,806. PNEUMATIC EJECTOR. EDWARD CYRIL BOWDEN-SMITH, Brockenhurst, England.

1,144,838. HAND-RAMMER OPERATED BY COMPRESSED AIR. JOHANN FRIEDRICH WILHELM GRIESE, Hamburg, Germany.

1,144,865. ROTARY PUMP, CONDENSER, OR COMPRESSOR. EDMUND SCOTT GUSTAVE REES, Wolverhampton, England.

1,144,931. VACUUM-CLEANER. ARCHER BOOGHER, Roanoke, Va.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XX SEPTEMBER, 1915 No. 9

TO GET DRY COMPRESSED AIR

BY FRANK RICHARDS.

In a recent interesting account of the compressed air installation for driving a tunnel, are mentioned two compressors, each with a rated capacity of 427 cu. ft. of free air per minute. Air was conducted to two receivers in the compressor house, one being 3 ft. in diameter by 8ft. 3 in. long, and the other 3 ft. 6 in. by 8 ft., then into the mine through a 4-in. pipe 3725 ft. long, more than ⅔ of a mile, to a receiver 3 ft. 6 in. by 8 ft., thence 350 ft. through a 3-in. pipe line to the starting point of the tunnels, and through 3-in. branch lines to within 50 ft. of the faces.

It was stated that the compressors were placed outside the mine "mainly to insure getting dry air, as the atmosphere inside the mine contains a large amount of moisture due to the sprinkling to lay the dust and the natural wet condition of parts of the mine. By having the compressors outside the mine, no trouble whatever was experienced from the freezing of the air drills."

The statement relating to the compressed air supply, and the complete avoidance of the freezing-up trouble, seems to call for some comment, since, as it stands, it embodies a prevalent misunderstanding as to the conditions to be observed in successful compressed air practice.

Those who have had much to do with the use of compressed air for driving rock drills, pumps, etc., are sufficiently familiar with the annoying presence of water in the air, and of the trouble it is apt to cause by freezing up and choking the exhaust passages. This was certainly not lost sight of in the description above referred to, since we are told in it that the compressors were located outside the mine "mainly to insure getting dry air," and also that "by having the compressor thus outside the mine, no trouble was experienced by the freezing at the air drill."

Of course, the story as told is true enough, and I have not the slightest doubt as to the facts or experiences narrated; it is only the deductions or explanations given about which there can be any question. Locating the compressor outside the mine for the purpose of getting dry air, and then the happy experience with the drills when there was no free moisture to freeze, and therefore no freezing up, had not the slightest relation to each other as cause and effect.

A little reflection must suggest at once that hundreds of compressors have been thus located outside mines and tunnels, where all of them could have been expected to get dry air just as surely as in this case; and yet it has been the rule rather than the exception that the drills or other tools driven by the air from these compressors have had a persistent habit of freezing up, not alone on account of the low temperatures of the exhaust, but also, and principally, because water was present in sufficient quantity to accumulate in the form of ice in the exhaust passages. Evidently something more is needed than the location of the compressor in this case to account for the immunity, and it is not difficult to find a sufficient explanation.

NO AIR IS DRY.

There is no such thing as dry atmospheric or "free" air. Whenever air is spoken of as "dry" it is only that it is drier than some other air. And how could it be otherwise, when one of the most important and perpetual functions of the air is the conveyance and distribution of water over the earth? Air is always drier in some places and wetter in some places than in others. Here are a few local mean percentages of atmospheric humidity from tables of the U. S. Weather Bureau: Galveston, 85; New York City, 73; Walla Walla, Wash., 65; Rapid City, S. Dak., 60; Salt Lake City, 53; Yuma, Ariz., 42; El Paso, 39. It is somewhat curious that the places of the highest and lowest humidity in the United States are thus both in Texas.

Moisture which is thus intermixed with the air is in the form of perfectly transparent and invisible vapor, until a humidity of 100 per cent, or the point of saturation, the dew point, is reached, which may be said always to occur in the compression and transmission of air at the ordinary working pressures, say 6 atmospheres or 75 lb. gage, and immediately that this point is passed, the excess of moisture condenses into actual water, but still mixed with the air, the super-saturated air then appearing as fog or mist. The freed water which forms the cloud will slowly settle out of the air if it is quiet long enough. If air in this condition is passing through a pipe, the water will wet the interior and trickle down to the bottom, where in time it will form a flowing stream and be carried along with the air current.

THE UNSTABLE DEW POINT.

The saturation point of air constantly varies, and is determined by its pressure and its temperature, especially the latter. At a fixed temperature any given volume of air is saturated when it contains a certain quantity of water vapor, and this almost regardless of the pressure, which affects the capacity of air for water vapor only by changing the volume. If the absolute pressure of a certain quantity of air is, say, doubled, by which the volume is reduced one-half, the moisture capacity is reduced in the same proportion, so that, if the humidity of the free air is 50 per cent, this humidity becomes 100 per cent when the air is compressed to 2 atmospheres, or 15 lb. gage, and if it is compressed to 6 atmospheres, 90 lb. absolute, or 75 lb. gage, a very common working pressure, the humidity becomes 300 per cent, and 200 per cent of this the air will refuse to carry as vapor.

That is, it would so refuse to carry this excess of moisture if its temperature remained constant, which thus far we have assumed to be the case, but that is far from the fact. As air is compressed its temperature rises rapidly, and with each rise of about 20 deg. its capacity for moisture is doubled. Starting with free air at 60 deg. F., if it is compressed to 75 lb. gage, its temperature at delivery, no matter how perfectly the cylinder may be water-jacked, will be above 300 deg., so that in consequence of this change of temperature, the capacity of the air for moisture will have been doubled so many times that when it leaves the cylinder the relative humidity will be quite low, although it still carries all the moisture with which it started. It might be called exceedingly dry air, and with the receiver placed near the compressor, as it generally is, its temperature in passing through the receiver will still be too high for it to get to a condition beyond saturation and release the water; and, as a matter of fact, under the conditions here suggested, little water is ever drawn from air receivers so located.

It is to be borne in mind that the conditions under which compressed air will have the lowest capacity for moisture are high pressure and low temperature. As the air leaves the compressor, and before it begins to be used, it is of course at its highest pressure, and in its flow through the pipes its temperature is reduced, so that when it arrives at the point where its work is to be done it should be at a low temperature and carry a minimum of moisture, if the opportunity has been provided for getting rid of the moisture as it condenses.

In the case under consideration, the air was conveyed through the pipe line more than ⅔ of a mile, and we may be sure that it was thoroughly cooled by the time it got to the end. Long before it got there, the saturation point was reached, and the water began to wet the pipe and to flow along the bottom as previously mentioned. This water would finally be carried into the receiver which, fortunately was provided at the far end of the pipe, and other moisture would separate from it while passing through the receiver, this water being drawn off from time to time. It was the presence of this receiver which prevented the drills from freezing up, by intercepting the moisture before it could get to the drills, not the locating of the compressor outside the tunnel, which really had nothing to do with it. A receiver or some means of catching the water after the air has made its run through the pipes is necessary, but it is not easy to see the use of the receivers near the compressor, if the line pipes are of reasonable size.

When 2-stage compressors are employed for ordinary working pressures, as is always to be recommended and is now quite customary, a little of the water may be intercepted in the intercooler, and much of it would be liberated by an aftercooler; but a receiver or a water separator at the end of the run is generally necessary to complete the work. More or less water is sure to be in the air in excess of its capacity, and its presence will assert itself if it is not disposed of.—*Practical Engineer.*

THE AUTOMOBILE TORPEDO

In the world-war which still rages with unchecked momentum the supreme terror is the submarine, and the submarine is nothing except for its torpedo. To our readers especially any information concerning the latter must make a strong appeal since compressed air, as will appear, is its breath of life.

The automobile torpedo is not a novelty. It was invented fifty years ago by an engineer of the Austrian navy named Lappis, who made his first torpedo in a shop at Fiume, a seaport on the Adriatic, owned by Robert Whitehead, an Englishman. The first torpedoes were called Luppis-Whitehead,' but the first part of the name soon dropped off and the Whitehead torpedo has been known all over the world ever since.

Soon after our civil war some twenty different nations bought the rights to use the torpedo and many of them have continued to develop it, the changes and additions not always coming to the knowledge of the public.

An elaborate description of the up-to-date torpedo has recently appeared in *Le Genie Civil*, of Paris, an abstract of this appearing later in *The Engineer*, London, whose cuts are here reproduced with necessarily an additional abridgement of the text

The earliest torpedoes were 14 in. in diameter, 14 ft. 6 in. long, weighing 600 lbs. and carrying a charge of 40 lb. of gun cotton, with a range of 450 yards and a speed of 20 knots. The torpedo of to-day has a minimum diameter of 17.7 in., a length of 20.5 ft. and a weight of 1540 lb. It carries 220 lb. of gun cotton and has a range of 1100 yds. at 43 knots or 8700 yds., at 28 knots, according to its type. Speed and long range cannot be combined in the same torpedo. Some of the navies have torpedoes much larger in all their dimensions.

The Whitehead torpedo as it is now made consists of: (1) The striker and detonator; (2) the explosive chamber; (3) the compressed air reservoir; (4) the machinery chamber; (5) the aft flotation chamber; and (6) the tail portion which carries the propellors and rudders, see Fig. 1.

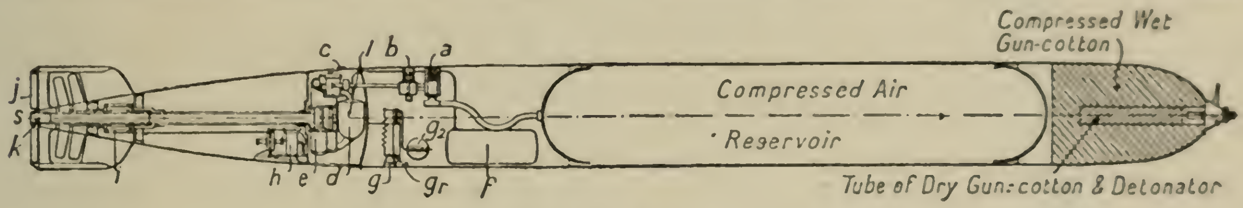


FIG. 1. SECTION OF WHITEHEAD TORPEDO.

The charge of explosive is contained in a metal envelope which can readily be detached from the rest of the torpedo, and which is called by the French the *cone decharge.* The explosive employed in the French navy is wet gun cotton, compressed into annular cakes, which are piled one on top of the other. In its wet state the gun cotton does not take fire if brought into contact with a flame, and is not detonated even by very powerful shocks. It can even be cut with a saw or drill if care be taken to avoid local heating. The amount of water used by the French for dampening is as much as 25 per cent of the weight of the gun cotton. The wet cotton is exploded by a small charge of dry gun cotton, which is itself exploded by a fulminating mercury detonator. The dry cotton is carried in a water tight cylinder, and it is put in its position at the head of the torpedo just before firing. The detonator is at the front end of the cylinder, and it is exploded by a striker when the torpedo comes in contact with an obstacle.

The striking head of the torpedo is shown in

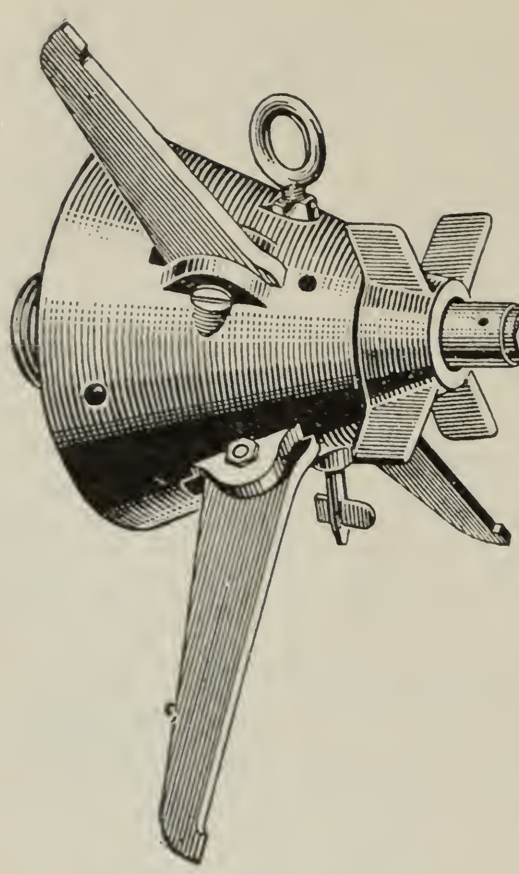


FIG. 2. THE STRIKER.

Fig. 2. The striker is, before the torpedo is fired, held out of action by a small propeller arranged in front of the striking head and screwed to it. As soon as the torpedo is traveling through the water, the propeller revolves and travels along the threads of the screw until it has reached a position which disengages the striker so that the latter is free to move and to explode the detonator, which it does at the moment of striking the object aimed at, whether by contact with the striker itself or with either of the three projecting levers.

Whitehead first tried the propelling of his torpedoes by the wind and then he used coiled up springs but finally adopted compressed air which has been used ever since. The pressure at first was about 1,200 lb. per sq. in., but to increase the speed the pressure was increased and as high as 2100 lb. was employed.

REHEATING THE AIR.

It was found, however, that so much cold was produced by the sudden expansion of the air at this pressure that ice appeared in such quantities that the operation of the machinery was interfered with. To counteract this it was determined to reheat the air inside the torpedo. The first device having this object was the apparatus of the Bliss torpedo. In this the combustible liquid was set fire to at the moment the torpedo was discharged. At the present time gasolene or alcohol is employed. It is contained in a separate reservoir and it is burnt in a special appliance called the reheater. M. Gesztesy also had the idea of injecting water in a fine spray into the heater. This water on being vaporized prevents an excessive increase of temperature and also increases the volume of the products of combustion all available for motor driving.

The Gesztesy system is shown diagrammatically in Fig. 3. The inflammable liquid, gasolene or alcohol, heats not only the compressed air but also the injected water which is thus vaporized and mingled with the air. In Fig. 3, A is the compressed air reservoir. From it a pipe *k* leads to cock C, from which another pipe k^1 leads to a pressure regulator D, which in its turn is connected by a pipe k^2 to a "retarder" I. From the latter the air passes to the combustion chamber or reheater E. Beneath the latter is a combustible reservoir F, from which a pipe *a* leads up to E.

The retarder I, shown in section in Fig. 4, has for its object the gradual setting in operation of the main engines, and the regulation of the supply gasolene and water to the reheater, as well as the firing of the combustible mixture. By this it is possible when firing a torpedo from an above water tube to delay the starting of the motor machinery until the torpedo is actually in the water.

The retarder consists, Fig. 4, of a cylinder provided with two pistons, N and N^1, both keyed to the same spindle. When the cock C, Fig. 3, is closed, so that no air is passing, the two pistons occupy the position shown; that is to say, they are pushed as high up as they will go in the cylinder under the action of spring O, and the piston N covers the discharge port D, Fig. 4, while the piston N^1 presses upward against the stop P. When the air is admitted through pipe A the pistons can only descend slowly, for first of all the resistance of the spring O has to be overcome, and then the oil which fills the cylinder underneath N^1 has to be forced through the hole Q as the piston descends; hence several seconds must elapse before port D is fully open.

Part of the Combustion chamber E, Fig. 3, is provided with double walls. There is first of all an outer case *b* which is seated on the

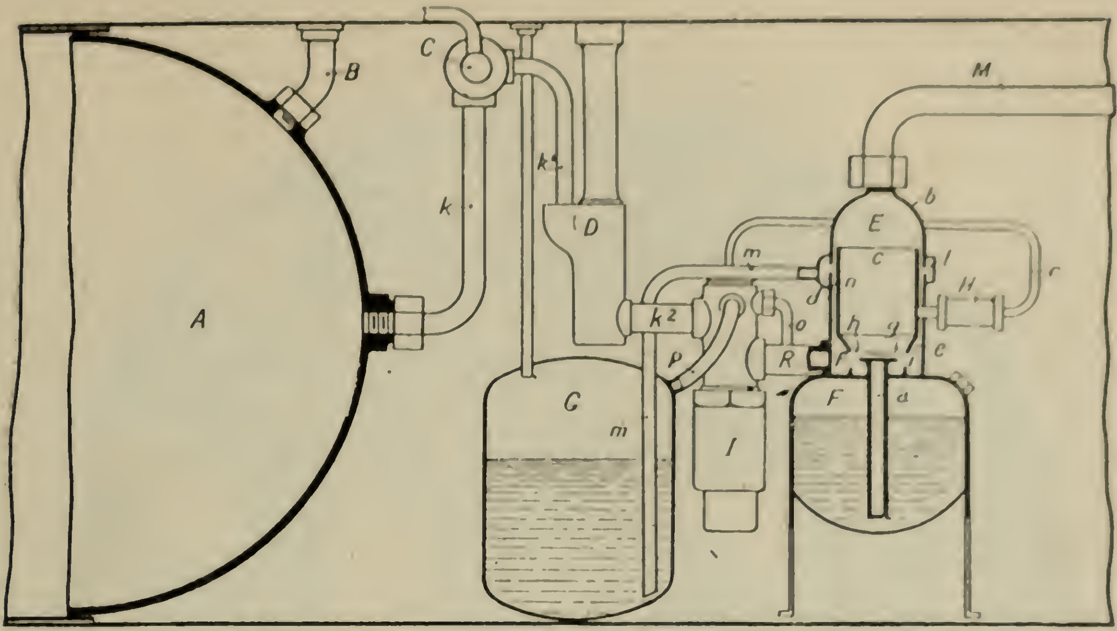


FIG. 3. GESZTESY REHEATER.

gasolene reservoir. Inside this there is a cylinder *c*, the bottom of which, having the form of a truncated cone, is furnished with an annular plate. It is this cylinder which is the combustion chamber properly so-called. Between the case *b* and the cylinder *c* there is an annular space *e*. The pipe *a* which comes upward from the reservoir is furnished with a cylindrical portion *g* which has transverse channels *h*. This portion *g* divides the lower part of the space *c* into two parts, of which the lower is in communication with the space *e* by means of the holes *i*. The air arriving from the reservoir A enters the annular space *e* through the pipe R. Around the cover or case *b* is a circular channel *l*, to which is attached the water pipe *m* and which communicates with the annular space *d* by means of small holes. A tube *o* joins the retarder I with the benzine reservoir and a tube *p* joins the retarder to the water reservoir G, so that the air pressure will tend to force the water up through the pipe *m*.

The lighting arrangement H is put in operation by the compressed air, which reaches it through the pipe R. As soon as the torpedo motor is started an inflammable substance, which burns slowly and remains lighted for about seven seconds, catches fire and the flames are led into the combustion chamber.

The working of the reheater may be explained as follows. As soon as the torpedo is fired the cock C, Fig. 3, opens and the air flows to the regulator, which reduces the pressure to that required for use. The air then flows through the retarder into the combustion chamber, in which it mingles in the annular space *d* with the combustible liquid coming up the pipe *a* from the reservoir F, and with water coming from the reservoir G. The air entering the space *e* is divided into two portions. One of these, entering through the holes *i* in the lower part of the combustion chamber, passes between *f* and *g* and lifts and pulverizes the benzine flowing from the orifice in the siphon *a* and pushes the vapor thus formed up to the level of H, where it inflames. The other portion of this air flows across the space *d*, in which it pulverizes the water which arrives by the pipe *m* and causes it to mingle with the products of combustion arriving from lower down in the apparatus. The air, the products of combustion and the water vapor then pass away together to the engine through the pipe M. The temperature in the combustion chamber rises to about 250 deg. Cent., and this is also the

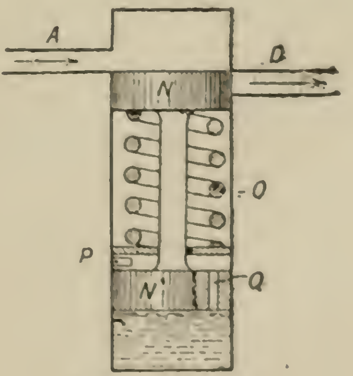


FIG. 4. RETARDER.

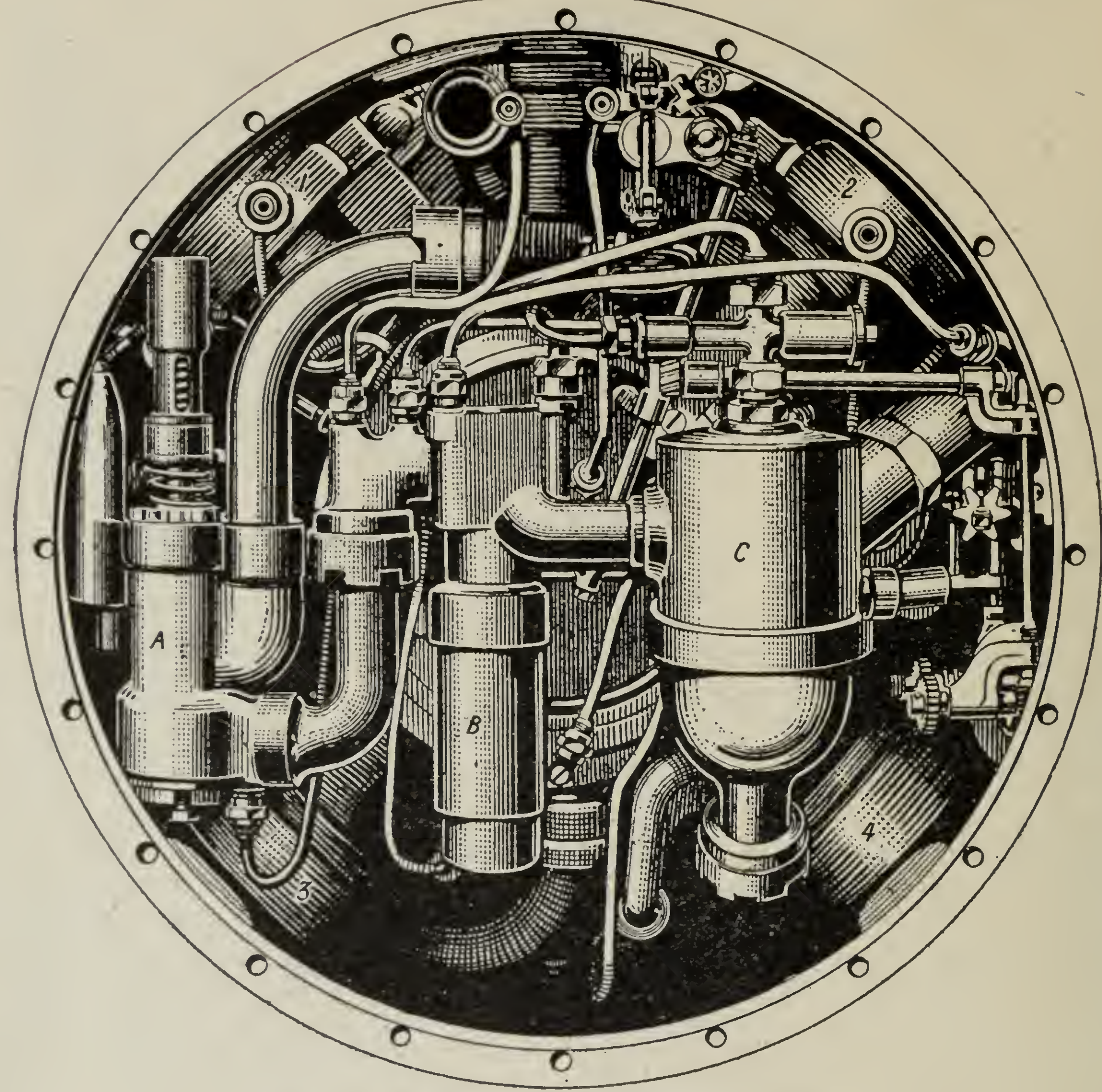


FIG. 5. SECTION THROUGH ENGINE COMPARTMENT.

temperature of the combined mixture, which is high enough to annul the freezing effect brought about by the expansion of the gases as they are exhausted from the engine. Moreover, the energy contained in these gases is greatly in excess of that in the air alone, and this fact has resulted in a considerable increase in the radius of action of torpedoes without an increase of their dimensions.

The motor which propels the torpedo is of the four cylinder Brotherhood type, with the cylinders arranged at right angles and all operating upon a single crank. It is designed to develop 120 horsepower with an air pressure of 570 lb. and at speed of 1200 revs. per min. The shaft is made hollow so as to allow the escape of the gases after doing their work, the exhaust being thus liberated at the rear of the propellers. There are two propellers, one rigidly secured to the main shaft and the other to a hollow shaft or sleeve. These shafts by the aid of gearing revolve in opposite directions, this being done to avoid irregularities in the travel of the torpedo and also to counteract the tendency to roll the torpedo over. A section of a Whitehead torpedo, taken through the engine compartment, is shown in Fig. 5. In this the four cylinders of the motor are designated by the numbers 1, 2, 3, and 4; the pressure reducer by A, the retarder by B, and the reheater by C.

Elaborate devices are employed for steering the torpedo and especially for controlling its striking depth. In these details there have been various developments, some of them more or less secret, so that no complete description can be attempted.

The arrangements for securing that the tor-

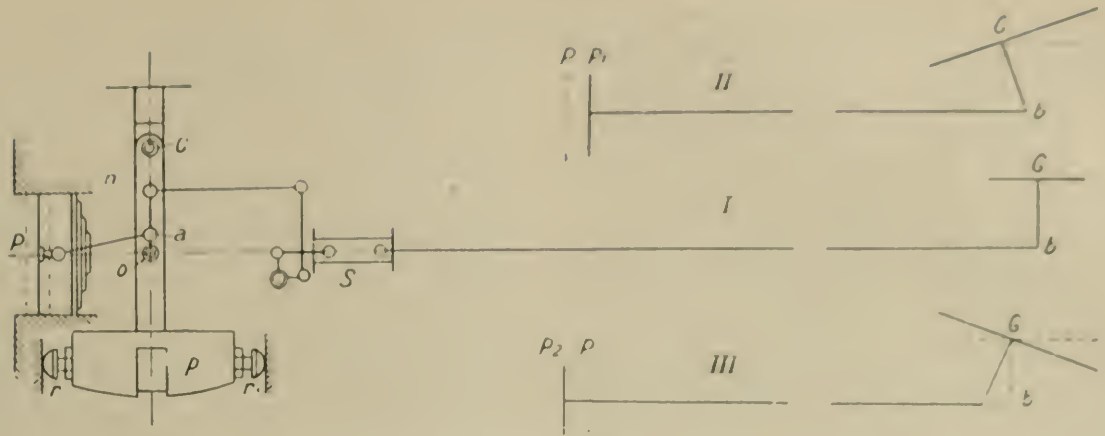


FIG. 6. DIAGRAM OF DEPTH CONTROLLING APPARATUS.

pedo shall strike the object at the desired depth are shown diagrammatically in Fig. 6. In this P is a piston, one side of which is open to the water in which the torpedo is immersed the other side being engaged by a spring, the pressure of which can be varied to suit different depths of submersion. The stroke of this piston is only a few milli-meters. A pendulum *p* is hung on knife edges at *c*, and its oscillations are limited to 3 or 4 degrees by means of spring buffers r r^1 pressing against stops. The movements of the piston P are transmitted by a connecting-rod to a point *a* on a lever which is pivoted at *o* to the pendulum *p*. The other end of the lever is connected to a relay or servo-motor S, which is worked by compressed air and which controls the position of a plate G which forms a horizontal rudder. The exact position of this rudder varies in different types of torpedo. In Fig. 7 it is in front at both sides of the propellers, as shown at *a*. In some cases, as is in fact seen in Fig. 1, the rudder is behind the propellers. If these plates be horizontal, as in diagram I, Fig. 6, the torpedo will travel horizontally. This will be the condition when the pressures on both sides of the piston P are equal. Should, however, the torpedo have a tendency to dive or to go into deeper water, the pressure on the water side of P would become greater than that due to the spring, and the consequence would be that the plate G would be brought to the angle shown in diagram II, Fig. 6. This would of course tend to make the torpedo rise to the surface. On the other hand, should the torpedo tend to rise to the surface the water pressure on P would be overcome by the spring and the plate G would be brought to the position shown in diagram III, and the torpedo would then be directed

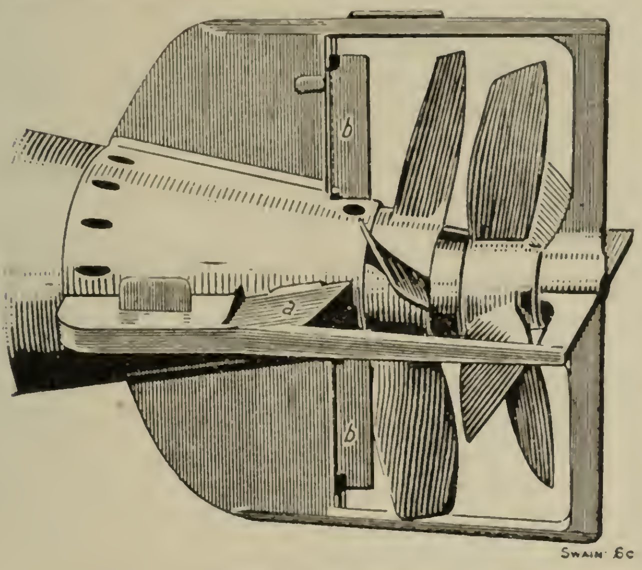


FIG. 7. RUDDER AND PROPELLERS.

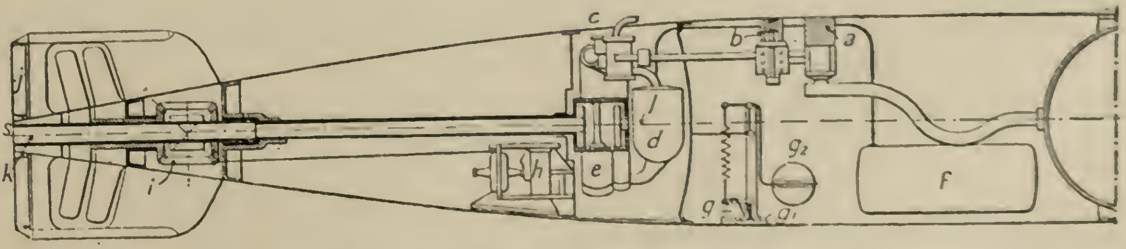


FIG. 8. SECTION SHOWING VARIOUS PARTS.

downward. When the pressures on the two sides of P become equal the rudder G again becomes horizontal.

As a matter of fact, what happens in practice is that the torpedo, which is very rarely fired at the depth at which it is intended to strike, eventually reaches that depth by a series of oscillations, the amplitude of which gradually decreases until the desired immersion is attained. The ordinary depth of immersion for the attack of battleships and cruisers is nearly 10ft. but torpedoes can be regulated for much less depths than this, so that the Germans have been able to use them with success against small merchant vessels and trawlers only drawing perhaps between 5ft. and 6ft. of water.

For controlling the direction of the torpedo vertical rudders—see *b b*, Fig. 7—are employed. These are controlled by means of a gyroscope. If the tendency of the torpedo is to deviate to one side or the other of the line in which it is aimed the gyroscope automatically brings it back again. Here, too, there are in practice oscillations of decreasing amplitude before an undeviating line is reached, since the torpedo, having deviated, is brought back over the centre line before it can be stopped. The relative positions of the hydro-pendulum and the gyroscope are shown in Fig. 8.

ROCK-DRILL NICKNAMES

Rock drills, like human beings, acquire nicknames. Some were derived from those of the pioneer drill manufacturers, others were originally trade names of the drills and gradually became accepted as representing that entire type of drill. In other cases the names are descriptive of the action of the machines. The pioneer in the rock-drill field was the Burleigh drill, introduced in the Hoosac Tunnel in 1866 by the Burleigh Rock Drill Co., of Fitchburg, Mass. This was one of the first large engineering undertakings in this country, the object being to tunnel the Green Mountains, the natural barrier to traffic between New York and the New England States. The Burleigh rock drills, later used in the Western mines in considerable numbers, were quite heavy and required two men to handle them. When the smaller, one-man drills were introduced, the runners still continued to call all heavy, two-man drills "burleighs," irrespective of make. Opposed to the "burleigh" is the "chippy," the name given to all piston machines lighter in weight and running more rapidly. As the demand on one-man drills in recent years has been for more and more speed and strength, the machines have increased in weight to such an extent that the application is now hard to see. The "Waugh" was one of the first stoping drills to appear. In some of the Western camps the miners still commonly refer to any stoper as a "waugh." Down South a stoper is commonly known as a "warrior," a peculiar development from the original name, explainable only by the colloquial peculiarity. For a similar reason, or lack of reason, the hollow-steel hand-hammer drill is commonly called a "murphy." The name "jap" is also sometimes applied to this type of drill, and is derived from the trade name "Little Jap." Among the highly coloured names sometimes heard among the miners for the stoping drill are the "wiggle-tail" and the "window-maker." The "wiggle-tail" is very descriptive of the operation of the machine, and the "window-maker" refers to the unhealthy effect the dust has on the miners' lungs. Fortunately, the introduction of sprayers, bags and atomizers for laying or catching the dust at the mouth of the hole, and the enforcement of the use of them by some State laws, are a start in the right direction toward making the last-mentioned name inapplicable. When the first self-rotating hammer drill was introduced several years ago, it was given the name of "Jackhammer" by the manufacturer. This name had taken such a hold by the time competitive self-rotating hammer drills appeared that it was found quite difficult to apply any other name which would be accepted and adopted by the drill men. With the one-man piston drills and the use of hammer drills for drifting, it appears only a question of time until the "burleigh," or heavy two-man piston drill, will be used very little underground. When the self-rotating stoper becomes fully developed and generally adopted, no more use will be had for the tail or the "wiggle-tail," and this creature will die a natural death. It would seem that, with the tendency toward lighter-weight hammer drills and self-rotation in stoping drills, the miner of the future will have an easy time of it.—J. R. McFarland, in the *Engineering Journal*.

POINTS ABOUT AIR-COMPRESSOR PRACTICE

BY R. H. ROWLAND.

The installation of a compressed-air plant calls for a large initial investment, but once established, it is not expensive to maintain. The first cost should not be considered too much, the work to be done should be well considered, and a plant established of sufficient size, not only to supply the present requirements, but to have ample margin to permit an increase of from 25 to 50 per cent. in air consumption. The installation should be first-class in every item, and in order to minimize the losses, only good workmanship and sound material should be used.

In order to properly determine, say for mine traction, the size of motor and the tank capacity, it is in most cases necessary to work out in foot-pounds the energy for doing this work. The factors entering into this calculation are: (1) Weights of the empty and loaded cars; (2) frictional resistance, which is dependent on the condition of road and rolling stock; (3) grade resistance, which is the severest condition of grade; (4) curve resistance, depending on the sharpness and length of the curves; and (5) the daily output and most desirable size of train. Having determined these conditions, the size of the motor and storage tanks required can be readily determined.

LAWS GOVERNING COMPRESSION.

To intending users of compressed air a knowledge of the laws governing the changes in the temperature, pressure and volume of air should be of value. They are as follows: Let

P, V and T = The initial pressure, volume and absolute temperature, respectively, of a given weight of air,

and

p, v and t = The final pressure, volume, and absolute temperature, respectively, of a given weight of air,

then

$$\text{At constant temperature, } PV = pv \qquad \text{(a)}$$

$$\text{At constant pressure, } \frac{V}{v} = \frac{T}{t} \qquad \text{(b)}$$

$$\text{At constant volume, } \frac{P}{p} = \frac{T}{t} \qquad \text{(c)}$$

The following formulæ apply if air be compressed or expanded adiabatically:

$$\frac{p}{P} = \left(\frac{V}{v}\right)^{1.408} \qquad \text{(d)}$$

$$\frac{t}{T} = \left(\frac{V}{v}\right)^{0.408} = \left(\frac{p}{P}\right)^{0.29} \qquad \text{(e)}$$

The units of work U required to compress a volume of air V to a volume of air v, or to compress a volume of air V from P to p, are:

1. Adiabatically, that is, without loss of the heat due to compression:

$$U = \frac{PV^{1.408}}{0.408}\left(\frac{1}{v^{0.408}} - \frac{1}{V^{0.408}}\right) \qquad \text{(f)}$$

2. Isothermally, that is, at constant temperature,

$$U = P\,V\ hyp.\ log\frac{V}{v} \qquad \text{(g)}$$

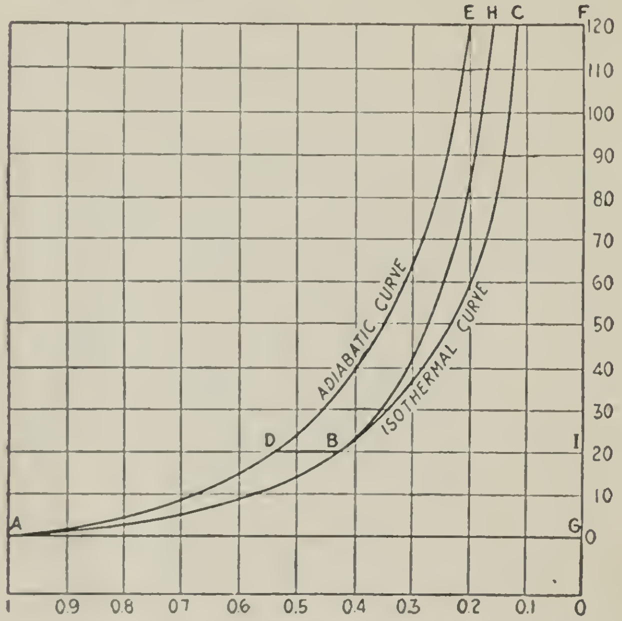
When air is compressed adiabatically, the rise in its temperature is an exact measure of the work done upon it: and therefore the units of work required to compress it can be calculated from the increase in temperature. The rise in temperature $t - T$ is given by (e), and the units of work equal this quantity multiplied by the weight of air in pounds by the specific heat of air at constant volume expressed in foot-pounds, namely, 130.2. Thus if W = weight of the air in pounds,

$$U = (t - T)\,W\,130.2 \qquad \text{(h)}$$

It is generally known that when air is expanded it becomes cooler, that its pressure, if confined, is increased when heated, and that it is cooled when the pressure is reduced: also, that the compression of air (or any gas or steam) is accompanied by a rise in temperature, but specific information regarding the resulting loss of power and the extent to which this heating effect can be neutralized by proper construction and design is not always accessible. There are two limiting conditions under which the compression of air may be accomplished.

Assume that a compressor compresses air at about atmospheric pressure and at 63 deg. F. into one-third of its former volume. It is known that at a constant temperature its pressure would then be 45 lb. absolute and

(45 — 15) 30 lb. above the atmospheric pressure. Inasmuch, however, as the temperature is not constant and rises, the compression into one-third volume will in this case actually raise the air temperature from 63 deg. F. to 360. This temperature should therefore give a pressure of about 55 lb. above atmospheric pressure instead of 30 lb., and if the air could be kept at this high temperature, it would remain at this pressure and the result would be perfect, inasmuch as when the air was used in the cylinder it would expand from 55 lb. above atmosphere to the atmospheric pressure, and at the same time would cool from 360 deg. F. to 63. If the heat of compression is removed as fast as generated and the compression proceeds under a uniform temperature, it is said to be isothermal, and the compression curve follows the line *ABC* in the diagram.



ADIABATIC AND ISOTHERMAL COMPRESSION.

If this could be accomplished, the air, when used, would give back practically the same amount of work as had been performed upon it in compressing, and if practicable, the heat absorbed from the air by the cooling agent could be applied to the air during its reëxpansion in use along a similar isothermal curve, the result being perfect thermodynamic efficiency. It is toward an approximate realization of these ideal conditions that compressor practice is directed, but in service the compressed air has to be taken a long way in pipes, and since these pipes radiate the heat, the air is correspondingly cooled; and if it should be cooled down to its original temperature (63 deg. F.) while still occupying the same volume, its pressure will have fallen to 30 lb. above atmosphere; and this is what does occur.

In the diagram the line *ADE* represents adiabatic compression, during which no heat is removed from the air and in consequence of which the temperature rises. The result of this rise in temperature is plain; since a given weight of air at a given pressure occupies a volume proportional to its absolute temperature, the volumes at all pressures are greater in adiabatic than in isothermal compression, in a ratio increasing with the pressure; and since the work of compression and discharge is represented by the area in the diagram to the right of the curve along which compression is accomplished, it will be seen that the area *ADECB* stands for the waste of energy caused by allowing the heat of compression to remain in the air.

The efficiency is the percentage which the power given out by the motor bears to the power required to compress the air in the compressor, and the ultimate power developed at the motor is often a small percentage of the power expended. In many cases losses are due to poor design and faulty installation, and the efficiency often may be as low as 30 per cent.; which would perhaps appear misleading and unfavorable if the manner in which the power is used were not considered.

LOSSES IN COMPRESSION.

In adopting recent designs, with all the latest improvements, the cubic feet of air compressed per hour per horsepower has been considerably increased. The power can be transmitted, say at a pressure of 60 lb., two miles distant with an efficiency of about 60 per cent. on the indicated horsepower of the compressor engine, and without reheating. By heating the air this efficiency can be raised to about 80 per cent.

The primary causes of loss are: First, generation of heat during compression, which passes away by radiation without producing useful effect; this loss of heat representing an equivalent loss of work. Secondly, during compression, the temperature of the air being increased, its bulk is increased. Also, during compression from atmospheric pressure to 45 lb. above, its bulk is increased so much by the increase in temperature that what should be two becomes three cubic feet in the air cylinder; whereas on leaving it, with reduction again of the temperature, the bulk is again reduced to two cubic feet, so that the compression is performed on a larger bulk of air than that which work is obtained from. This is the most important point. Thirdly, inability to get full expansion out of the compressed air at the motor. The air on arriving at the motor is at or near the temperature of the atmosphere and always holds some moisture in suspension. On expanding in the cylinder of the motor, its temperature will fall so much that the moisture will freeze and ice will form in the exhaust passage of the engine.

Other causes of loss, or secondary causes, are: Resistance to air passing through suction and delivery valves, clearance losses in cylinder, leakage past the piston, losses from friction of mechanism, losses in air mains from leakages, and from friction in air mains of too small diameter.

There have been several methods adopted for diminishing the loss of power in compressing air, and the primary losses described above have to some extent been obviated by surrounding the compressor cylinders with cold water, or water-jacketing, so that the surface of the cylinder shall not be heated during compression. This reduces the volume of the air, and consequently less work has to be done upon it to compress it, and therefore less heat is generated in compression. By this means the temperature is not raised high, and therefore less heat, that is, less work, is lost by radiation during the operation. It is also necessary to cool the cylinders for other reasons, such as lubrication and the packing of the piston rod and valves. Also, when the cylinder is very hot, the air that enters from the atmosphere is at once heated and expanded, before the inlet valve has closed; and thus the air compressed by each stroke will fill a smaller volume when it has cooled in the receiver and pipes. This smaller volume at equal temperature and pressure represents a proportionately smaller quantity of work.

MULTI-STAGE COMPRESSION.

Another method is to adopt stage compression with intermediate cooling, which means discharging the air from the cylinder after partial compression has been effected, completely removing the heat generated during the first compression and then compressing to final pressure in another cylinder. This method is called two-stage compression, and when repeated one or more times for high pressures, multi-stage compression.

In two-stage and multi-stage compression the air may be compressed to 35 lb. in the low-pressure cylinder, then passed through the intermediate cooler to the high-pressure cylinder for further compression. For pressures of four atmospheres and upward, the extra first cost, etc., of a stage compressor will pay for itself in a short time, because the loss which arises from heating of the air increases rapidly as the pressure increases. Stage compression reduces these losses.

Cylinder jackets are indispensable in keeping the cylinder walls sufficiently cool for effective lubrication and in the prevention of cumulative heating. At ordinary speeds the indicator diagrams from an air cylinder show a compression line approaching the adiabatic curve much more closely than the isothermal. Diagrams having compression lines deviating considerably from the adiabatic are naturally regarded with suspicion, and leaks through the valves or past the piston may be considered probable.

The chief advantages of multi-stage over single-stage compression are:

1. Lower average temperature, resulting in lower average pressure and permitting the compression of the same volume of air with less expenditure of energy.

2. Increased safety and ease of lubrication. When high final temperatures prevail, part of the lubricating oil vaporizes, and wear on the piston and cylinder becomes rapid. Under exceptional circumstances the combination of air and oil vapor may reach the proportions of an explosive mixture, and if the compression temperature passes its flash point, damage may result. Such accidents are rare even in single-stage work; in multi-stage compression, with proper intercooling, they are improbable, if not impossible.

3. Greater effective capacity in free air. The final pressure in the low-pressure cylinder is much lower than in the single-stage machine, and the air confined in the clearance spaces when expanded to atmosphere occupies comparatively little space. Consequently, the in-

flow of air through the suction valves begins at an earlier point in the stroke.

Referring again to the diagram and assuming the compression in each cylinder to be adiabatic, the compression curve is represented by the interrupted line *ADBH;* the compression proceedingly adiabetically in the first cylinder to *D;* the air then being withdrawn and cooled in a suitable vessel, usually called an intercooler, until its initial temperature is reached and its volume reduced from *AD* to *AB;* with good intercooler arrangements it may be further reduced, being then introduced into a second cylinder and compressed adiabatically, as before, along the line *BH.* The energy required to compress and discharge a given quantity of air under isothermal conditions (perfect efficiency) is proportional to the area indicated by *ABCFG.* The waste energy in two-stage compression (proper conditions, of course, being assumed) is proportional to the two smaller areas *ADB* and *BHC;* while the loss of energy in adiabatic (approximately single-stage) compression is represented by the whole area *ADECB.* The saving effected by constructing the air end for two stages is, therefore, represented by the portion *DEHB.*

PREVENTING ICE FORMATION AT EXHAUST.

As it is uneconomical to use air without expansion, some means must be adopted to use it expansively without being encumbered with the freezing difficulty. Several methods have been devised for heating the air before it reaches the motor, so as to obtain the necessary expansion and avoid the freezing. When compressed air is used to drive an engine, the air has already cooled down nearly to its former temperature. When it is expanded in the cylinder down to atmospheric pressure, its temperature falls very low, and thus its pressure on the piston falls much more rapidly than it would if the temperature remained constant. When the air is exhausted its temperature is usually much below the freezing temperature of water, and therefore, the moisture in the air is frozen on the exhaust valves and causes much trouble by choking them with ice. In the writer's opinion, the best means to adopt to diminish the loss from this cause would be to provide air receivers of a large size, both near the compressor on the surface and near the engines underground, where the air is used; these, together with air mains of ample dimensions, would give sufficient time to deposit moisture, and with large and straight exhaust passages no trouble need be experienced from ice, because if there is no water or moisture, there can be no ice.

In dealing with the secondary losses that may occur by the suction valves not being large enough or the springs upon them being too strong (the negative suction pressure sometimes amounting to 2 or 3 lb. per sq.in. —a serious loss of power), valves actuated mechanically are to be preferred, but these are more suitable for large-sized compressors, and are often found to be too great a refinement for small ones.

ATTENTION TO DELIVERY VALVES

Delivery valves should be properly adjusted, capacious, easy and quick in action. They should open immediately the piston pressure equals the receiver pressure and should close again immediately it becomes less. The compressor cylinder should be frequently indicated to see that the valves are in proper working order.

Clearance losses also are troublesome. The piston should, of course, work as close as possible to the cover, so as to reduce the clearance space to a minimum. Only the best kind of piston rings should be used in the air cylinders. The piston of an air compressor is more difficult to keep tight than a steam piston; the moisture from the steam helps to keep the piston ring tight, but the reverse happens with dry air.

LOSSES DUE TO MECHANICAL FRICTION

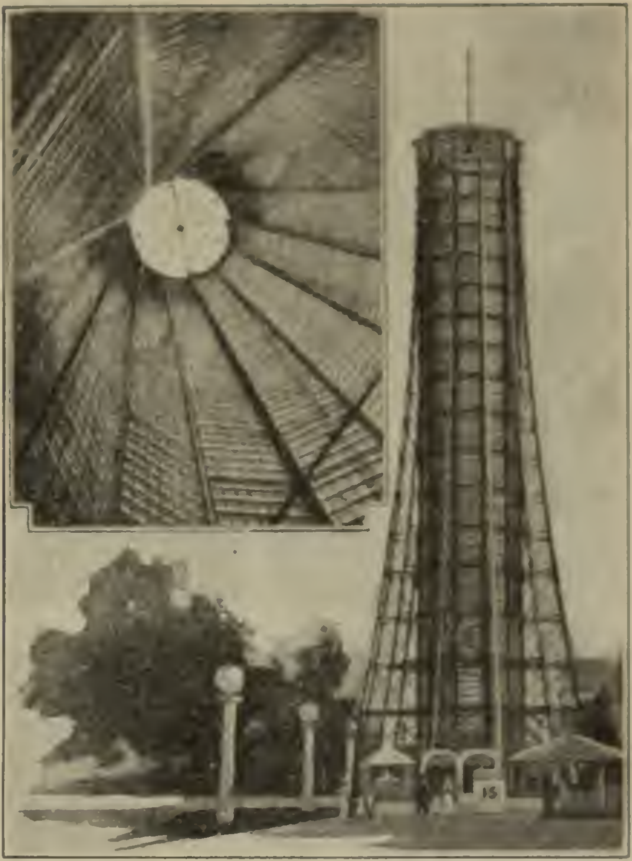
The losses from friction of mechanism depend chiefly on the accuracy of workmanship, the arrangement of the compressor and the efficiency of lubrication; all of which should be well attended to in the design and future working of the compressor. Equally so, good and reliable workmanship will often result in diminishing the losses from leakage in the air mains. In poor arrangements great loss will result from leakages at the joints of the air pipes, and more care is necessary with these than with steam pipes, because a leakage of steam can easily be seen, whereas small leakages of air cannot. Good joints should be made at first, providing properly for contraction and expansion, and they will give little trouble afterward. The air mains should be sufficiently large. The loss due to friction in air mains increases, not directly as the velocity, but as the square of the velocity. Should the air mains be too small, it is evident that the air will be wire-drawn, the pressure will be diminished, and the greatly increased velocity will produce increased friction. The delivery in the pipes should be more than equal to the quantity that the engines worked are capable of taking out.

WHEN TO USE SINGLE—AND WHEN TO USE MULTI-STAGE COMPRESSORS.

The decision of air-power users in regard to the method of compression must be the result of compromise between considerations of first cost and running cost. Below 60 lb. terminal pressure the adiabatic loss is comparatively trivial, and within this limit and at low altitudes single-stage compression is to be recommended. Between 60 and 100 lb. the amount of fuel is usually the determining factor in a choice, though high altitude may also enter the question. Above 100 lb. both safety and economy speak for two-stage, and above 500 lb., multi-stage compressors.

With increase in altitude, the atmospheric pressure decreases from 15 lb. per sq.in. at sea level to about 10 lb. at 10,000 ft. above sea level. Since the density of the air decreases with its pressure, it is obvious that at such altitude the total weight of air handled by a given displacement is considerably less than at sea level and that to fill any volume with air compressed to 90 lb., a greater free-air displacement will be necessary than would be required at sea level. As the heat generated during compression is dependent upon the number of compressions, and since this number when compressing, for instance to 80 lb., is considerably increased at higher altitudes, it naturally follows that two-stage compression is more imperatively needed at high altitudes than it is at sea level.—*Power*, somewhat abridged.

A PNEUMATIC OBSERVATION TOWER



PNEUMATIC OBSERVATION TOWER.

The half-tone here reproduced from *Popular Mechanics* shows the essential features of a novel observation tower for popular amusement which has been built at or near one of the parks of Chicago. It may be described as a glass cylinder or tube 200 feet high and 30 feet in diameter traversed by a piston which is driven up the tube by compressed air carrying within or upon it a load of passengers up to 125 at a time. The tube is not strictly cylindrical, having 12 flat sides which are composed of more than 1,000 window sashes with over 15,000 panes of plate glass. There is of course a heavy and elaborate steel framework amply strong and staged to resist all possible stresses, with a liberal factor of safety. The glass lining is said to be capable of resisting an internal pressure of 10 lbs. to the square inch, while to raise the full load of passengers to the top only ¼ lb. per square inch is required. There are rods over the top to prevent the carriage from being driven up out of the tube and besides this precaution there are posts provided near the top of the tower which will permit the surplus of air to escape when the carriage reaches the top. About two and a half minutes are used for the ascent and the descent is completed under control. The operation of the device is said to be entirely satisfactory. Visitors of course have a practically unobstructed view all the way up as well as when reaching the top.

IMPROVEMENTS IN DECOMPRESSION OF DIVERS

In diving to locate the sunken submarine "F-4," outside of Honolulu harbor, Chief Gunner's Mate Frank Crilley of the United States Navy broke all deep-submergence records by going down to a depth of 288 feet.

The public has been amazed by this performance, and has naturally wondered how the human body could withstand the enormous pressure of the enveloping water at that depth. However, that record does not outstrip the possibilities of our physical endurance. No less an authority than Prof. J. S. Haldane, M. D., F. R. S., has declared, "It would seem probable that a man supplied with air in the usual way might dive to about four hundred feet!" Why, then, is it that so many under-water workers have heretofore lost their lives through asphyxiation, paralysis, etc., after dives at much more modest depths and following their return to the surface in apparently sound conditions? In answering this we shall tell how Crilley and his mates have done the work they have, and, at the same time, we shall acknowledge our indebtedness to that committee, instituted by the British Admiralty some years ago, which blazed the way to our present fuller understanding of the physiological circumstances involved in pressure work, whether it be that of the diver or the sand hog in the caisson. The human body is decidedly complex and all parts of it are not reached by the arterial circulation in the same period of time. The capillaries carry the blood much more slowly than do the active arteries of the main circulation, and, again, the tissues fed by the capillaries take up the blood at a still more sluggish rate. Reversing this process, the blood that has reached the tissues returns to the venous ebb of the main circulation last, and this may mean a lag of an hour or more under some conditions. Let us see what is the possible outcome of this tardiness.

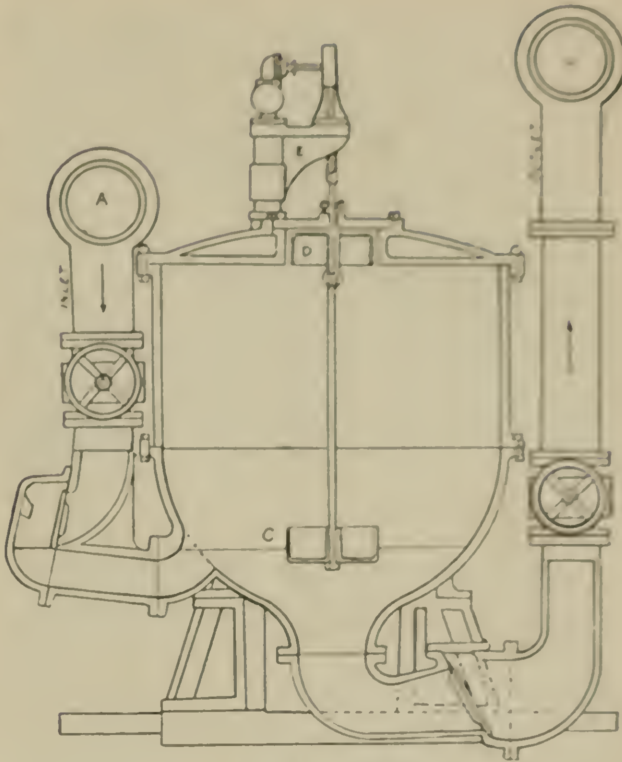
When a diver breathes air under pressure, the blood in the cells of the lungs absorbs the air under that pressure—both the oxygen and the nitrogen—and the arteries carry it into the body. The longer the man is under pressure the farther the absorbed gases will be carried into the system by the stages we have already described. The higher the pressure the more serious this becomes as the body reaches general saturation. Now a considerable part of the oxygen undergoes a chemical change through its action upon the body substance, but not so with the nitrogen, and all that is absorbed in the system must again pass out by the circulation in such fashion that the gas shall not have a chance to produce bubbles. The deeper the nitrogen, carrying with it its initial pressure, penetrates the tissues the longer the time required to make sure of its retreat in its soluble union with the blood.

If nitrogen bubbles form through a diver's sudden ascent or decompression, and those bubbles press upon nerve centres or grow in volume enough to choke the heart and thus block the normal life stream, then paralysis or death, as the case may be, will follow. While the general circulation will quickly adjust itself to lessened pressure, the capillaries and the outlying tissues are much more tardy and the welfare of the diver hinges entirely upon the time devoted to his decompression But the British investigators established, among other things, this fact of prime practical importance—something of the utmost commercial value. No matter how deep the diver had gone or the length of time of his stay on the bottom, it was perfectly safe to bring him up quickly, at the rate of a foot a second, to a depth corresponding to half of the total absolute pressure to which he had been subjected. For instance, if he had been down to a depth of 175 feet, with a hydrostatic pressure of 75 pounds and an atmospheric pressure of 15 pounds, making a total of 90 pounds, it would be perfectly proper to bring him up to a point where the combined pressures did not exceed 45 pounds, or let us say, 70 feet below the surface. This sudden rise of 105 feet would still insure against the formation of nitrogen bubbles in the body, while it would get the man out of the more dangerous pressure zone below.

Were he brought up slowly from 175 feet, as was so long the practice, the greater pressure and the length of his time in it would have driven the nitrogen deeper into his tissues and thus increased the measure of his saturation. From 70 feet up, the period of decompression can be abridged by 10-foot stages of ascent, and these concluding steps or pauses are lengthened as the surface is neared —the longest halt being the last one below the surface when the final surcharge of nitrogen is brought into the general circulation and carried out of the body with the breath. When Crilley's associate, Drellishak, led the way in this deep-water work, by going down to a depth of 274 feet, he was held, when ascending, at ten feet below the surface for more than hour. In this manner, recourse to the recompression chamber was obviated.

But so eminent an authority as William Wallace Wotherspoon, who had charge of the salvage operations on the "Empress of Ireland," where his men worked 160 feet down in very cold water, believes that a distinct advance can be made in the art by bringing the men to the 10-foot depth as now, but then to take them out of the water and to put them into the recompression chamber for decompression—thus avoiding the long suspension in the water near the surface, which must sap the vitality. He logically believes it is better to place the men in the chamber, where they can rest after getting out of their diving dress and damp garb, and, if necessary, be given something warm to drink. A sudden squall would endanger the life of a diver hanging overboard from a vessel a short distance below the surface, and practical commercial reasons would argue in favor of substituting the recompression chamber for a prolonged halt at the final stage of ascent.

Despite the extraordinary work of Crilley and his companions at Honolulu, a word of warning is due to those who prophesy that divers will soon be able to go still deeper. It must be remembered that compressed air means compressed oxygen as well, and oxygen highly concentrated in this fashion becomes a pronounced irritant when inhaled for a considerable period. Crilley, himself, developed pneumonia shortly after his last submergence, and the condition of his lungs since has been of a grave character. While science has made it possible for the human body to battle successfully with the heavy pressures of deep submergence, it has not done away with the chemical problems that must of necessity persist. An excess of oxygen will inflame the lungs when exposure exceeds certain physical powers of endurance. In this, we see one more barrier that nature interposes to man's penetrating farther into the ocean's depths. —*Scientific American.*



SKETCH OF SHONE EJECTOR.

TEST OF A SHONE EJECTOR

BY C. S. MOORE.*

The Shone ejector, a device for raising sewage by means of compressed air, has been in use more or less for nearly forty years. It may be clearly understood by reference to the above cut.

Sewage is admitted through the inlet pipe A, gradually rising in the ejector till it reaches the under side of the bell D, thus enclosing therein the air at atmospheric pressure. As the sewage continues to rise above the edges of the bell, this air is compressed sufficiently to raise the bell with its attached spindle, thus opening the compressed air admission valve E. The compressed air thus admitted exerts pressure on the top of the sewage, the check valve in the inlet pipe A closes, that in the outlet pipe B opens, and the sewage is forced out of the bell-mouthed bottom opening through the outlet valve and the raising main, to the outlet pipe B, which communicates directly with the gravity sewer. As the sewage passes out, its level falls till the cup, C, is left full of water unsupported by the liquid pressure, whose weight causes the cup to descend pulling down the bell and spindle and thereby reversing the compressed air admission valve, which first cuts off the supply of compressed air, and then opens the exhaust valve through which the air in the ejector exhausts down to atmospheric pressure. The outlet valve falls on its seat, the inlet valve opens, and the sewage fills the ejector again, driving the air out through the air exhaust valve as it rises. The positions of the bell and cup are so adjusted that the compressed air is not admitted till the ejector is filled with sewage, and is not allowed to exhaust till the sewage has fallen to the discharge level. The spindle is attached at the top to a lever provided with an adjustable counterweight, which, acting as a balance to the weight of the cup, C, permits a range of adjustment of the discharge level from a level where the falling sewage first leaves an appreciable weight in the cup, to a level which clears the cup entirely.

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*Abstract of Thesis in Cornell Civil Engineer.

In Ithaca, N. Y., two of the four collecting mains of the sewerage system are brought to an ejector station, where the sewage is lifted 8 feet by two 500-gallon Shone ejectors placed in a circular chamber 13.3 feet diameter, whose floor is 22 feet below the street. One of these ejectors was tested for efficiency, as described below.

In this plant compressed air is supplied through an air main of 6-inch cast iron pipe 4,018 feet long. Compressed air is furnished by two Rand Drill Co.'s Class B steam air compressors, connected to a receiving tank whose gauge pressure is kept between 13 and 15 lbs. The air and steam cylinders of this plant were fitted with Crosby indicators. The revolutions were recorded by a continuous counter. A thermometer cup was inserted in the flow pipe for the air cylinder jacket-water and the outflow led by pieces of rubber hose to the weighing tank on small platform scales. Another thermometer cup was inserted at the junction of the air pipes from the two compressors.

To be complete, the test required:

1. An efficiency test of the compressor.
2. An efficiency test of the air main.
3. An efficiency test of the ejector.

Since the ejector plant had to be kept in operation more or less continuously, a number of half-hour runs for the compressor test with fifteen-minute intervals, was adopted, and seven such runs were made with the compressor pumping through the nozzle. Steam and air cards were taken from each side of the compressor every five minutes, as were also readings of the continuous counter, air-tank and air-nozzle gauges, with corresponding temperatures, weight and initial and final temperatures, weight and initial and final temperatures of jacket water, and temperatures of the room and of the outside air. Seven runs were made and the average efficiency of the air cylinder was found to be 77.87%.

For the efficiency test of the air main, the same method was adopted and the same readings taken, except that the air nozzle with its gauge and thermometer was removed from the receiving tank and attached to the end of the air main in the ejector chamber, where the atmospheric temperature was noted. Five runs were made and the results were as follows: Averages of mechanical efficiency both runs, 83.05%, run number two, 48.94% efficiency for air delivered. Efficiency from steam cylinder to nozzle on ejector=83.05×.4894=40.64%. Efficiency of transmission=.4894÷77.87=62.85%.

For the efficiency test of the ejector, a three-hour continuous run was made with the ejectors performing their regular duty, the southern ejector discharging at intervals of three and one-half minutes and the northern at intervals of forty-five minutes. Steam cards and readings of the continuous counter and of the tank gauge were taken at the compressor at intervals of ten minutes, while at the ejector were taken the number of ejections and time of discharge and gauge readings just before, at the minimum pressure during and just after discharge.

It was decided to measure the volume of discharge in order to be more certain of the results, and to siphon out and measure the contents of the ejectors. It was found that the capacity was 481.5 British gallons, or 578.1 U. S. gallons, instead of the 500 gallons claimed.

The average for runs 1 and 2 of the ratios between the respective horsepower totals gave for the mechanical efficiency of the compressor 83.05%.

The number of cubic feet of air pumped per minute through the nozzle during Run No 1 having been found from the nozzle calibration curve, the energy stored therein was calculated. The average percentage of these results to the I.H.P. of the air cylinders is 77.87%, which represents the efficiency of the air cylinder, taking into account the loss due to heating and compressing the air.

For Run No. 2 in the same way the efficiency referred to the air cylinder was found as 48.94%, where the efficiency of transmission through the air main becomes 48.94÷77.87=62.85%. From the data of Run No. 3 were computed the efficiencies of the entire plant from the I.H.P. of the steam cylinder and the H.P. of the ejector computed on the basis of 4810 pounds of water lifted per each ejection through:

1. An effective lift of 8.17 feet from the inflow pipe to the end of the discharge pipe one block distant.

2. A pump lift of 15.37 feet, being the above lift plus the friction head due to forcing the sewage through 451 feet of 12-inch iron outlet pipe, which flows full during the time of the ejector discharge (about 14 seconds). This corresponds to a velocity of 7 feet per second, for which the friction head was calculated to be 7.2 feet.

3. The actual lift of 17.96 feet, being the pump lift plus the lift due to the fall of the sewage from the entering main to the top of the ejector dome (0.59 feet) plus the additional lift due to the center of gravity of the ejector contents being about mid-depth of the mass (2 feet) below the top of the dome.

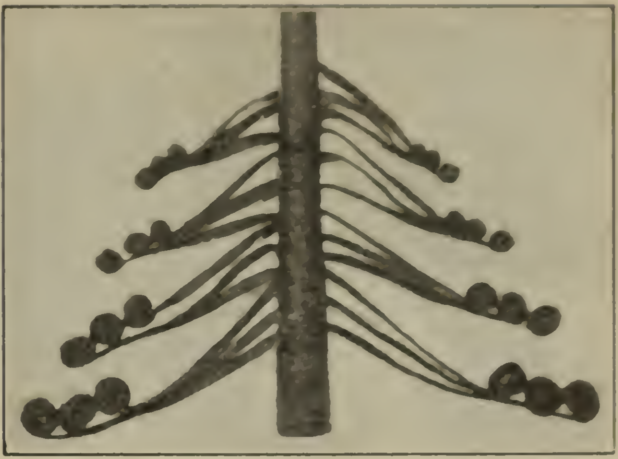
The average efficiency of effective lift was found to be 7.39%; of pump lift, 14.01%, and of actual lift, 16.39%.

From these efficiencies and the efficiency between the steam cylinder and the nozzle in the Run No. 2 (i. e., 48.94% of 83.05%=40.64%) the corresponding efficiencies of the ejector proper were determined, as follows:

Efficiency of ejector=Eff. of total plant÷Eff. from steam cylinder to nozzle in Run 2.

The efficiency of the ejector for the actual lift (40.33%) may be considered very satisfactory. The efficiency of the total plant is low on account of the low efficiency of transmission.

It is said that the only standard of size that is uniform all over the world is that of moving-picture films, which are universally made 1⅜ in. wide.



WEAVING THE WRAPPING.

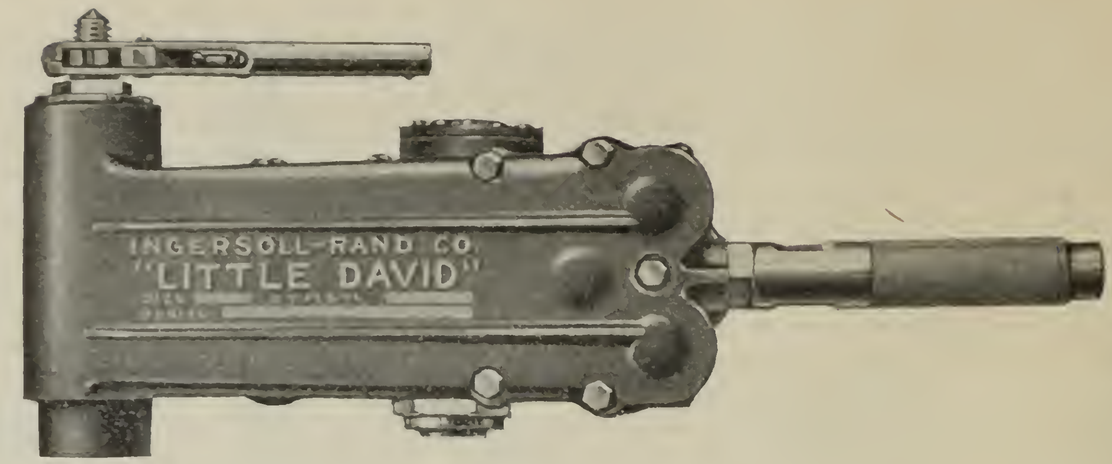
SUBERS PROCESS AIR BRAKE HOSE

The construction of this hose is clearly shown in the half-tone. In the making of what is termed wrapped hose, which has been in general use, the fabric is cut on the bias, overlapped and wrapped directly over the tube. The lap of the fabric in hose of this type varies the thickness often as much as 1/32 in., and when it is cut through a section shows that the fabric is not thoroughly impregnated with the rubber.

Under the Subers process the wrapping material consists of parallel cords combined into strips, each strip consisting of about 288 strands and being about 1/2 in. wide by 1/16 in. thick. Every strand is separately coated with rubber compound, which binds the strands in each strip firmly together, the impregnation of the fabric being thus very complete. The strips are wound helically about the tube or lining of the hose, there being two complete layers in each direction.

Hose of this construction shows a specially high bursting pressure, and the distorting effect of the pressure is minimized. The elongation per foot per 1,000 lb. pressure will average about ⅛ in., with an expansion of 1/16 in. in the diameter, there being no twisting or contracting.

At the present time the manufacturers of this hose, The Goodyear Tire & Rubber Company, Akron, Ohio, are confining their production of this type of hose to the standard air brake hose in lengths of 22 in., but later they expect to adapt the process to the manufacture of hose for pneumatic tools and other services.



FOR METAL DRILLING IN CLOSE QUARTERS

The drill here shown is specially adapted for working effectively close up to some obstruction and in places inaccessible to the usual types of rotative pneumatic tools. As to this point it is sufficient to say that the distance from the outside of the case to the center of the drill spindle is only 1 5/16 in.

The motor is of a novel three cylinder design operating in a constant bath of oil. The valve is of the rotary type and is gear driven from the pinion of a three way crank shaft. This crank shaft is operated by three ratchet levers which directly connect the pistons to the drill spindle, one or another of these levers being always in the driving position, so that the rotation is steady and constant. The feed when drilling is by means of a hand operated ratchet as shown. The drill has a No. 4 Morse taper socket and is rated for drilling up to 3 in. diameter, and for reaming and tapping up to 2 in.

This is a recent addition to the "Little David" line of pneumatic tools manufactured by the Ingersoll-Rand Company, 11 Broadway, New York.

AUTOMOBILE COSTS

On June 1st, of the present year, the number of automobiles in the United States for the first time reached 2,000,000. Figuring on an average of four persons to each car, which is conservative, there are 8,000,000 people in this country in daily enjoyment of motoring. To run 2,000,000 cars for one year requires at the very least 1,000,000,000 (one billion) gallons of "gas," worth $130,000,000; 20,000,000 gallons of lubricating oil, worth $8,000,000; 12,000,000 tires, worth not less than $16 a piece, or $192,000,000; accessories and extra comforts, goggles, gloves and caps, at $50 per car equals $100,000,000; garage charges on short tours (exclusive of gas and oil) $100 per car per year, $200,000,000; repairs made necessary by wear, tear and accident (exclusive of tires) $50 per car per year equals $100,000,000. Total running expenses for all cars in use, $730,000,000. Add thereto the value of the 600,000 new cars purchased during the year, at an average price of $750 equals $450,000,000, we get the immense total of $1,180,000,000 spent in a single year (1915) on the sport of motoring.

COMPRESSED AIR CLEANS CONCRETE ROAD SURFACES

On certain parts of the California highway system now under construction it has been found that before the surfacing oil could be applied, sufficient dust had formed on the concrete base to interfere with the proper bonding of the oil. After some experimenting a compressed-air apparatus was improvised which satisfactorily removes all dust and loose particles on the surface, it is stated, without requiring any extra trips over the road.

The device consists of a small air compressor mounted on the oil truck itself and geared to its main driving shaft. From the pump compressed air is conveyed to a 1¼-in. pipe fixed horizontally about 2 ft. above the road surface and 2 ft. ahead of the oil spreaders. This pipe is perforated by 1/32-in. holes spaced 1¾ in. apart. The air is delivered at a pressure of about 30 lb. per square inch and is said to drive off a continual cloud of dust even when working over a surface on which ordinary inspection shows no appreciable quantity of dust particles.

MAINTENANCE OF PNEUMATIC TOOLS IN RAILROAD SHOPS

At the convention of the International Railway General Foremen's Association, Chicago, July 13-16, the following was contributed concerning the care and maintenance of pneumatic tools in railroad shops.

J. J. Sheehan (N. & W.)—When the delicate construction of the working parts of the pneumatic motor and hammer and the narrow margin between efficiency and inefficiency are considered, it will be found that there are no tools in the shop that receive harsher treatment.

TO HAVE CLEAN AIR.

Facilities must be provided for the removal of water and dirt from the air before it enters the pneumatic machine. The removal of water can be accomplished by having a suitable sized settling tank provided with a drain valve, close to the point of operation. The most effective strainer for keeping the dirt out of the tool is that made of a double thickness of muslin placed in the air line back of the tool. The pneumatic tools must be kept properly lubricated. On the Norfolk & Western a satisfactory and cheap lubricant has been found in mineral lard oil, one containing marked emulsifying properties. Drills and hammers should be standardized as far as possible, both in styles and sizes, as it makes the maintenance easier and a smaller number of repair parts are required.

HOLDING DRILLS WHEN REPAIRING.

A simple arrangement for holding air drills while they are being repaired consists of a plain screw jack which has outlived its usefulness as a jack. The handle of the drill may be placed in the hole in the head of the jack and clamped with a set screw inserted at the top of the jack. This will readily permit of holding the drill firmly in any one position desired. It is important to know, after a drill has been overhauled, what per cent of its rated energy it will exert. Fig. 1 shows a method of making a rough test for this purpose. A hydraulic jack is placed in a frame in which is placed the pneumatic drill. A hardened friction ball is placed in the drill socket and runs in the corresponding friction bearing in the top plate of the frame. The pressure cylinder of the jack is connected to the gage at the top of the frame. After the motor is started the feed screw is screwed down on to the jack, increasing the friction of the ball in the socket, thus giving a combination of torque and thrust, exactly what occurs in feeding a twist drill. The area of the contact between the ball and the roughing surface may be regulated to give the friction desired. If the record of a drill of a particular class when new is 800 lbs. on the gage, this will be considered 100 per cent efficiency. All other tests of the same class of drill are compared with the original record, and no drill is allowed to pass below 75 per cent.

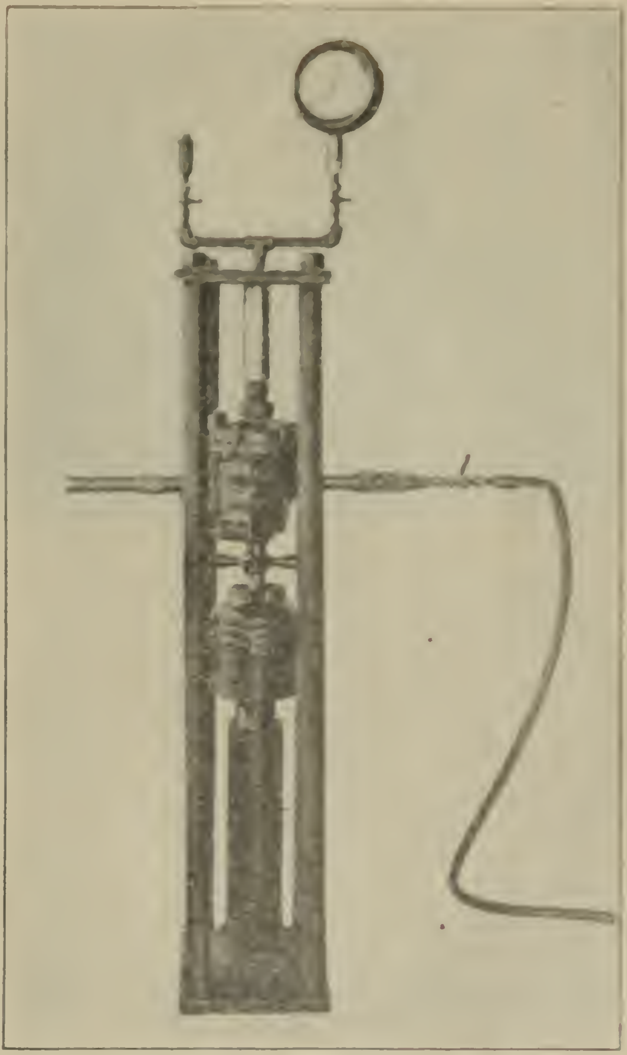


Fig. 1

CORRECTING FOR WEAR.

A drill failing to meet the required pressure is thoroughly examined for wear. In many instances the piston will be found to have been worn. It is expanded, by heating, .002-in., then a turned plug of the required diameter is inserted and the piston allowed to cool on the plug

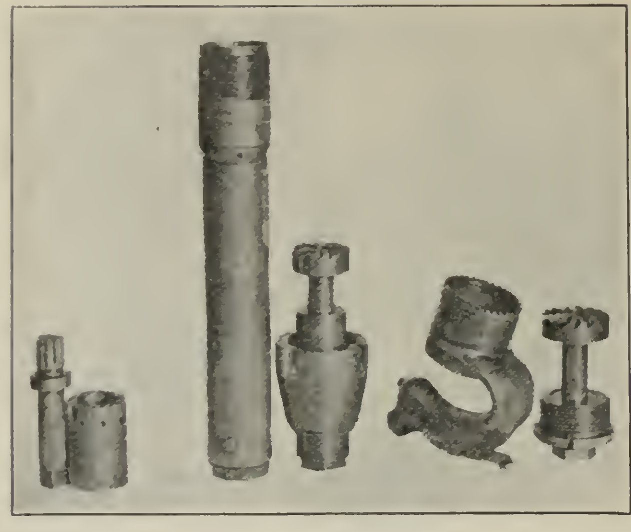


FIG. 2.

The plug receives the heat from the piston, and after it is sufficiently cool, it can be easily removed, leaving the piston expanded the proper amount. Cylinders have also been closed on certain classes of drills by pressing through a block bored to the required size. This has produced satisfactory results.

In the pnuematic hammers it is found that if the valve casing is worn .002-in., the hammer will be unfit for service. In order to locate the difficulty in this respect a new valve is kept at hand to try the hammers. The valves are purchased .002-in. over size, thus allowing a certain amount of reaming to put them in working condition. It has also been possible to take worn valve casings and roll them in a sheet iron roller, closing them a sufficient amount to put them in serviceable condition. The joints between the head and the cylinder, and between the head and the valve casing, should receive close attention. When they become uneven and leak the facing tools shown in Figs. 2 and 3 are used to correct the trouble. The feed nut for the facing tool serves as a guide.

John B. McFarland (N. Y. C. & St. L.)—The air motors for the use of the boilermakers are kept in the boiler shop, and those for the machinists are kept in the tool room. Once a week they are filled with lubricant and inspected. The hammers are cleaned and oiled once a day when in use. We have overcome trouble with broken tangs on the square chuck sockets by cutting off the left-hand thread on the chuck, replacing it with a right-hand thread, and screwing on a nut. The other end of the nut is made to fit the threaded end of the motor, the nut tightening on a shoulder at the same time that the taper shanks tighten in the motor sockets. With the chuck fitted in this way it is possible to drive a square socket tool to the capacity of the motor.

In the small hammers a bushing with a taper hole is used, and a taper shank is made on all tools. The bushings are reamed out with a No. 2 Morse taper reamer, which leaves a hole about ¾ in. on the large end and allows the use of ¾ in. octagon chisel steel for tools. This has stopped the breakage of shanks on such tools. A bushing will last from six months to a year before it becomes too large to impair the stroke of the hammer. This has been tried on large hammers with good results.

PROPER SELECTION OF PNEUMATIC TOOLS.

E. G. Nabell (Southern Ry.)—In selecting pneumatic tools, the economical operation and the cost of maintenance should receive the first consideration, not the first cost. As a means of producing better maintenance and higher efficiency from pneumatic tools the operators should be educated to use the tool that is best adapted for the work at hand, and to take proper care of the tools, particu-

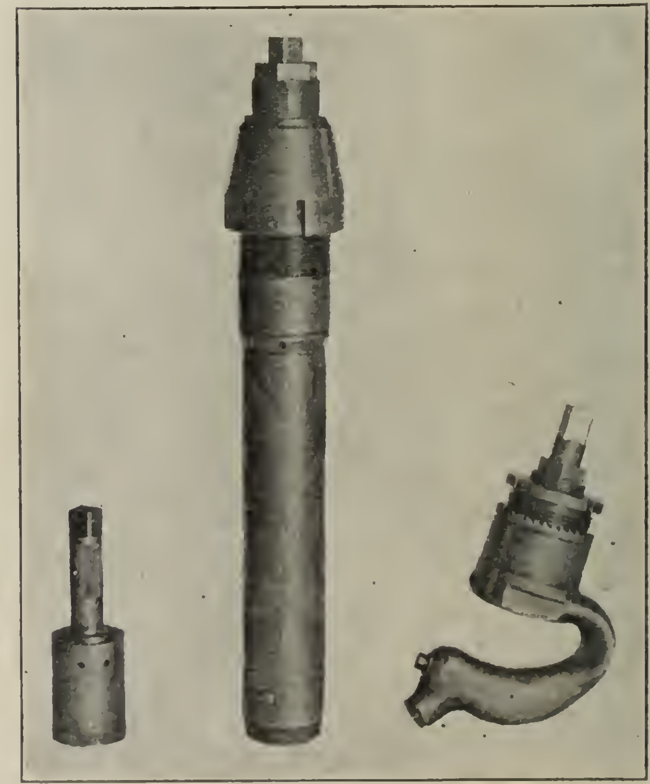
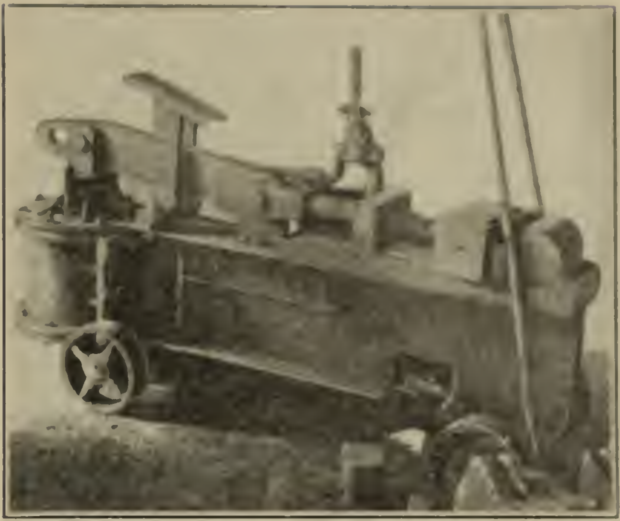


FIG. 3.

larly with reference to dropping them or striking them with a hammer, or allowing grit or any foreign substance to get into the throttle of the machine when it is not connected to a hose. All pneumatic tools should be inspected and tested at regular intervals, cleaned and thoroughly lubricated with a good grade of lubricant. By keeping a close record of the repairs to the tools it will be possible to determine just what and how many repair parts should be carried in stock. When the tools are sent to the tool room for repairs they should be taken apart and thoroughly cleaned. An air hammer, when not in service, should be kept submerged in a good quality of light clean oil to insure the thorough lubrication of all parts and prevent rusting. Where possible, it is desirable to confine the repair work on pneumatic tools to one mechanic who has become thoroughly familiar with the tools.

August Meitz (M., K. & T.)—It is a good policy to adopt a standard for pneumatic tools on any one railroad system. This would reduce the cost of repairs and maintenance about 50 per cent, as well as reduce the expense for repair parts to be carried in stock. The operators should be educated in the matter of the proper use of pneumatic tools; that is, they should use high-speed motors when they are required, and slow-speed motors when they are required. Much damage is done to the motor, as well as to the tool, when this is disregarded. Good engine oil should be used to keep the motors lubricated, and it will also be found to pay to use some light grease, such as Keystone or vaseline, in the crank case. The motors should be kept in good repair and inspected regularly. It has been found to be good practice to place the hammer, after it has been in service, in a solution of gasolene and signal oil, mixed half and half, as small particles of rubber from the hose lining frequently lodge in the chamber between the handle and the throttle valve. The gasolene will cut the rubber, and by blowing the hammer out with compressed air the refuse and foreign substances will be removed.

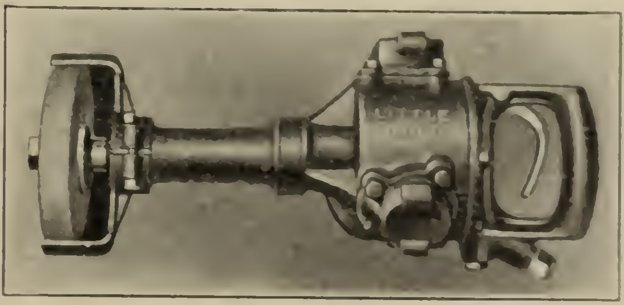
In the list of patents for the week of July 27 there is a series of six for apparatus for the pneumatic conveying and handling of ammunition. The claims of the six patents number 231.



A PORTABLE PNEUMATIC BULLDOZER

The half-tone here reproduced from *Railway Age Gazette* shows a home-made pneumatic tool such as may be expected to be found in railroad shops where there is always a ready supply of compressed air. This is a portable pneumatic bulldozer made in the Rock Island Railroad shops, Silvis, Ill. It is a very serviceable tool, normally for blacksmith work, which can be run around anywhere and connected with the air line as most convenient.

The air cylinder is at the left, the piston rod attaching to the long arm of a bell crank which operates the ram or plunger. Various bending forms may be used and punches of any size or shape. The body of the machine is a piece of heavy I beam which is mounted on small cast iron wheels. The lower part of the beam is notched out near the front to allow short cramping of the front wheels for turning in close quarters.



A PORTABLE PNEUMATIC GRINDER

The half-tone shows a handy portable tool especially adapted for trimming the surfaces of heavy castings and similar work in foundry and machine shop, a recent new output of the Ingersoll-Rand Company, 11 Broadway, New York. This is an air operated tool using the usual shop air pressure, carrying an emery wheel up to 8 in. diameter at speeds up to 3,400 r.p.m. The motor is a three cylinder engine with connecting rods attaching by ball bearings to a single crank on the central spindle. This spindle has a ball bearing on each side of the crank and another close to the grinding wheel. This is all enclosed in a dust proof aluminum case with a constant bath of oil for the motor. The valve is of the rotating type, forming a detail of the crank-shaft and working in a renewable bronze bushing. No gears or pinions are used in the construction. The entire operating mechanism is readily accessible, the loosening of six cap screws removing the handle end and exposing the entire interior. The cylinders are renewable independently of the casing and are interchangeable, as are also the pistons and rods. The lugs outside the cylinders will be noticed; these being provided to take the knocks if the tool is carelessly thrown around.

JACKHAMER DRIFTING COSTS

At the Colby iron mine, Bessemer, Mich., drifting is done by use of Jackhamer auger machines, using two men for one machine. These two men do only the drilling and are followed by a blasting gang and a tramming gang for each drift of the six different headings where this system is used. The size of the drift outside of timber is 8x9 ft. During the period in question 2517 ft. of drifting was accomplished in 112 shifts, which is equivalent to 11.3 ft. per man per shift. The costs per foot are as follows:

LABOR.		
Miners	$0.412	
Trammers	.990	
Timbermen	.360	
Trackmen	.121	
Blasters	.116	
		$1.999
SUPPLIES.		
Lagging	$0.094	
Timber	.210	
Explosives	.330	
Light, steel, shop labor, etc.	.060	
		.694
Total		$2.693

The foregoing figures include cost of breaking the ore, tramming it to the chute, timbering the drift, laying track and necessary supplies for the same except the cost of rails.—*Engineering and Mining Journal.*

YOU CAN'T TELL ME NUTHIN

BY BERTON BRALEY.

"You can't tell me nuthin'," the pitboss, he says;
"You can't tell me nuthin' a-tall,
I don't need advice from no hunkies like you—
An' if I do need it, I'll call;
I guess I kin tend to my business o. k.
Without no attention to nuthin' you say.

"You can't tell me nuthin'," the pitboss, he says;
"I reckon I'm on to my job,
An' I'll thank you to keep your suggestions to home,
You miser'ble ignorant slob;
I haven't no time fer to hear your idees;
I guess I'm the boss an' I'll do what I please."

Yes, that was the way that the pitboss come back
When I made a suggestion, polite,
But the Super he heard what the pitboss had said
An' he wasn't contented—not quite.
"Hold on there," he says, when the pitboss got through,
"I guess I'll horn in with a brief word or two."

"They can't tell you nuthin'," the Super repeats.
"Then Lord help you, brother," says he,
"For the guy who imagines he's knowin' it all
Aint quite the right pitboss fer me.
If YOU can't learn nuthin' from no other man,
I'll go get a feller for pitboss who can.

"We haven't no use fer the feller," he says,
"That thinks he has knowledge to burn,
Who scorns all suggestions that comes from his men
An' won't never listen an' learn.
They can't tell *you* nuthin'—them words makes me tired,
An' I'll tell you something right now—you are fired!"

Coal Age.

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EVERYTHING PNEUMATIC

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PNEUMATIC ACTIVITIES IN NEW YORK

It seems to be worth while to note one or two local indications of the part which compressed air is playing in the constructive engineering operations at present in progress in New York City. The larger operations, the driving of the tunnels under the East River, with compressed air performing the threefold function of resisting the water pressure, of pumping out the unavoidable inflow and of operating the rock cutting apparatus, is a familiar story which requires no retelling.

On the land in connection with the same work there is constant employment of compressed air in various ways. One of the new subway lines under construction in lower Manhattan runs for a considerable distance up Greenwich Street and immediately under the tracks of the elevated railroad which follow the same street for the entire length of it. At the lower end of the street the subway excavation is in solid rock, which gives steady employment to a lot of Jackhamer drills which seem to have entirely superseded the old heavy reciprocating types. Farther up there is more earth than rock excavation, but whatever the nature of the ground all operations are carried on without any interruption of the traffic overhead. This means not only that the tracks above have to be temporarily supported but also that all the pillars have to be extended downward or to be rebuilt upward from the level of the subway floor.

This rebuilding of the structural supports has required the removal of much of the original steel work, to be replaced by other columns, girders, etc., differently arranged and in this destructive work compressed air has been called to render its efficient aid in another way. Oxygen, as we all know, comes to us now commercially through the air liquifying process, and the oxyhyphen (in this case Blaugas) torch has been doing its wonderful work of steel cutting here quite extensively, so that it has made a brilliant daily display of itself where in use.

While all this subway construction work has been proceeding rapidly without interrupting the elevated travel it has happened, to complicate matters, that a great and important work of rearrangement and reconstruction of its track for express service has been carried on by the elevated railroad company. This has required much construction entirely new, the details of which we need not go into here, and in this work pneumatic tools, drills and riveters especially, have worked with their usual efficiency. It is not easy to see how all these things could possibly have been done without the aid of compressed air and also of highly compressed management.

SOME NEW BOOKS

Attention is called to the following new and entirely up-to-date books which should be of interest and value to our readers, published by John Wiley & Sons, Inc., New York.

Gas Power, by C. F. Hirschfeld, M. M. E., and T. C. Ulbricht, M. M. E. 219 Pages 7¾ by 5¼ in., 60 illustrations, Price $1.25 net.

This book gives a good insight into the theory of the heat engine problem, the use of fuels as gas producers, the development of gas power, details of gas generators and modern types of gas and gasoline engines. Every automobile owner or driver should be well versed in the working of his engine and a little study of this book should be of great assistance.

Mechanism of the Steam Engines by Walter H. James and Myron W. Dole, 180 pages, 9 by 6 in., 183 illustrations, Price $2.00 net.

Electricity and compressed air have not in the least belittled the steam engine as the supreme prime mover, and a knowledge of both theory and practice as applied to steam was never more essential to the man who aims at success in power application. This book treats of all types of engines from the simplest horizontal to the latest turbine. It treats of the use of the indicator, discusses valves and valve setting, governing and controlling devices. It is essentially practical rather than theoretical in its makeup.

Power and Power Transmission, by E. W. Kerr, M. E., 403 pages, 9 by 6 in., 325 illustrations, Price $2.00 net.

This book covers a broad field, and the fact that it has already gone to its third edition is a practical endorsement of its value. It treats of the elementary details of all machinery: shafting, bearings, friction and lubrication, pulleys and belts, toothed gearing, screws, cams, links, etc. Then it gives a very complete treatise on the steam engine in all its varieties and applications, also its various appurtenances and accompaniments. A third section is devoted to pumps, gas engines, water power, air compressors, air motors, etc. The various chapters are supplemented by examples to be worked out.

Mechanical Refrigeration, by H. J. Macintire, M. M. E., 356 pages, 9 by 6 in., 121 illustrations, 51 tables, Price $4.00.

This is a work representing an unusual amount of labor in its preparation. Many of the illustrations in the list are large, inserted, folded diagrams embodying curves of various data. The types of refrigerating machines are described, their construction is discussed and the auxiliaries treated of. The theories of mechanical refrigeration are stated and the choice and properties of refrigerating media. Then comes the testing of the refrigerating machine with several interesting chapters on ice making, cold storage, cooling of air, cooling of liquids and solids and other applications of refrigeration. The appendix gives a collection of pertinent examples, tables and data.

A CAT CATASTROPHE

A peculiar and somewhat mysterious accident occurred recently in the building of the Society for the Prevention of Cruelty to Animals, New York City. A rectangular steel tank, 5 ft. high, 5 ft. wide and 10 ft. long, used for asphyxiating cats and dogs exploded while in use, blowing out some of the windows of the building, but doing little other damage.

The cats to be killed are placed in the tank and illuminating gas from the city mains is then discharged into it, expelling some of the air. In this operation there is more or less mingling of the gas and air, and an explosive mixture is thus formed. In this case the mixture was ignited, causing the explosion; but the question is as to what fired it. In the reports in the daily papers it was suggested that the sharp claws of the cats clawing the sides of the tank must have struck a spark which ignited the charge, but this is not easily credible. Cats' claws are not sparkers, but a cat's fur when properly agitated is one of the best known sources of electric sparks. It is easy to believe that when the gas was first admitted the cats, smelling the gas and suspecting that something was going on, began to jump around, or perhaps to fight, and rubbing against each other could easily have furnished an igniting spark.

THE AMMONIA FUNCTION IN REFRIGERATION*

BY ALBERT JOHNSON.

Let us see how anhydrous ammonia becomes a conveyor of heat. When one pound of anhydrous ammonia has passed through the regulating valve into the low-pressure pipes it remains a liquid until it can grab hold of from 500 to 600B.t.u. of heat. Then the pound of liquid changes into a pound of gas. But it refuses to change from liquid to gas until that much heat leaves the room and enters the liquid ammonia on the inside of the coils, thereby turning it into gas.

The changing of the liquid into gas is what absorbs the heat. Therefore, it is always necessary to have plenty of liquid ammonia within the low-pressure pipes.

Do not, under any circumstances, allow gas to pass through the regulating valve, for then you only add heat to your rooms instead of subtracting it. Remember, the gas is the loaded vehicle, while the liquid is the unloaded vehicle, being empty. The liquid has plenty of room for heat units, but the gas has little room for heat units, since it is already loaded with them. It cannot carry any more. So it is well to watch and see that only liquid passes the regulating valve into the low-pressure pipes.

Bear in mind that it requires heat to vaporize ammonia—the more heat, the quicker the evaporation; whereas, the less the heat, the slower the evaporation, which explains why "sharp freezers" are so apt to fill up with liquid in abundance, while the rest of the system may be suffering from the lack of liquid.

After the liquid has been changed into vapor by the heat, it has practically spent its energy as a refrigerant, for the gas has obtained its full load of heat and is ready to carry it away.

So far the ammonia, or vehicle, has been "running down hill," requiring no power. At the bottom of the hill is the loading platform where the heat is taken aboard. After this it's an uphill pull, and a good strong horse is required to pull it up to the unloading platform. The horse may be called a "refrigerating machine."

The machine gets behind the heat-laden gases in the frosted low-pressure pipes and pushes them up to the top of the hill to the unloading platform, or ammonia condenser, where the loaded gas is changed back into a liquid. Just at the moment when the gas becomes a liquid it releases or dumps out the heat that it formerly picked up in the rooms, and the water in the condenser then absorbs the released heat units and carries them away.

Thus we see how necessary is the refrigerating machine to push the loaded vehicle, ammonia, along the uphill grade of high pressure direct to the top, or unloading place, at the condenser. But that is all it has to do, for the real work of freezing is performed by the ammonia, not by the machine. The initial as well as the final operation is done by the vehicle called ammonia, which must not be forgotten.

Thus you can readily see how anhydrous ammonia actually becomes a so-called vehicle for removing heat units from insulated rooms and carrying them, with the aid of the refrigerating machine, upstairs or downstairs, around corners and angles to condensers, there to unload its heat. Then it goes back to repeat the operation.

A regulating valve controls the flow of liquid ammonia into the low-pressure pipes. That is all it is there to do. It cannot do any freezing, since only the ammonia does that. I mention this because, way back in the early days of this industry, somebody misnamed that valve—the expansion valve—without thinking of the consequences.

Ever since then many operators got the erroneous idea that this valve actually did the heavy work of freezing, and they would fondle it and handle it, fuss over it and play with it, sometimes resetting it twenty times a day, then listening to hear the gas gurgle or spit through it. The misnaming of this valve has cost the owners of plants hundreds of thousands of dollars in time lost fooling with it and in lack of efficiency caused by relying on this valve during critical moments of climbing temperatures, when the receiver should be watched instead. It is best to call it a regulating valve, to save confusion of ideas, much money and false impressions.

When I speak of heat-laden gases in suction pipes it may surprise you. Try to put your hand on a frost-covered suction line and imagine it contains real heat. It actually does, and lots of it, only it is called latent heat, or insensible heat. A thermometer cannot register it, nor can you feel it by touch. But it is there just the same. Apparently, the pipe is very cold, for it is usually covered with frost, yet the cold gas inside of that pipe will deliver heat enough to warm up enormous quantities of condensing water from 10 deg. to 30 deg. Fahr. per pound.

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*Read before the American Meat Packers' Association.

We learn how the vehicle ammonia is relied upon to take the initiative in the work of removing heat. It is essential to work with not only dry, but pure ammonia. Note the difference between dryness and purity, for volatile hydro-carbons may exist in the liquid itself, which cause abnormally high pressures. Such foul gases refuse to liquefy and they fill up the condensers.

These bad gases must be blown away. Hydro-carbon gases are both colorless and odorless, which makes them hard to find. They are hidden, and like latent heat we know them by the effect they produce when they refuse to liquefy, causing excessive fuel bills or power bills and great ammonia consumption.

It has been estimated that in order to purge 15 pounds of uncondensable or hydrocarbon gas from the system you lose 85 pounds of pure gas, because the two are closely associated or intermingled, so that when the purge valve is opened the good as well as the bad gases are liberated unavoidably together.

GOOD AMMONIA REQUIRES NO PURGING.

Good ammonia requires no purging, for good ammonia is free from volatile hydrocarbons. The evaporation test does not disclose the presence of volatile carbon compounds, for they evaporate together with the ammonia. The working test seems to be the most reliable. The test for air in shipping cylinders means little as to quality and has the disadvantage of being deceptive.

Ammonia is like fullers' earth, because both require a working test to prove their effectiveness. In both cases results count more than analysis. A chemical report on fullers' earth is about as valuable as a chemical report on anhydrous ammonia. However, in making an exhaustive examination of ammonia a thorough chemist will demand to see the raw material as well as the finished product. In testing cement, for instance, a thorough chemist will also examine the clinker or raw material as well, in order to obtain data for proper valuation. The clinker may be overburnt or underburnt, and the chemist is right in demanding a sample of the raw material.

The purchase of anhydrous ammonia should be like the hiring of a man. You expect a man to perform some service and keep on doing so. In purchasing ammonia you must expect it to serve you by picking up or absorbing all the heat units possible and unloading them in large quantities day by day, without getting tired or worn out on the slightest occasion. Remember, you do not buy ammonia like other merchandise, to be sold to others from the shelf. Instead of that, you invest your money in an article that must work for you day and night, and produce results in heat-carrying capacity. For, to produce one ton of refrigerating duty the vehicle, ammonia, must fetch and carry away 288,000 B.t.u. of heat from insulated rooms in the shortest time possible, and that is why the question of ammonia as a heat vehicle is so serious as to affect the profits in a refrigerating plant.

A VISIT TO AN ALASKA GOLD MINE

The following account of a formal visit to a mine in full operation in Alaska, taken from the Alaska Daily Empire, published at Juneau, is unusually realiste and should be read with interest.

The party of legislators, mining engineers and representatives of the press which took advantage of Supt. P. R. Bradley's invitation to inspect the workings of the Alaska-Juneau mine and mill yesterday, returned to town with high grade specimens of ore, a fund of information and words of praise for Mr. Bradley, whose patient courtesy had made the trip possible.

The party left the Alaskan in autos at 10 o'clock sharp, were supplied with slickers and other apparel for their comfort and hoisted to the motor railway. There they boarded cars and were sped along the scenic heights, through the 6500 foot tunnel and out into the open stretches interspersed with lesser tunnels, until they entered the electric lighted mining tunnel proper.

A mile or so of this brought them to the hoist which lifted them up the 55 per cent. shaft to the surface where they looked out across Gold creek basin at the buildings of the Ebner property, the Perseverance toward the head of the stream resembling a fort on the heights, the glacier at one side, and lastly at the crumbling ruins of the old stamp mill where the Alaska-Juneau mine had first been picked at—a scene, as Senator Millard afterwards said, which caused him to see in fancy the first prospector toiling up the rough creek bed with a pack on his back, and in his hand carrying a pick for a staff.

Level No. 2 was next visited, this being a wide irregular chamber, apparently covering a couple of acres of floor space, out of which the ore had been taken and where a hive of men were sorting and wheeling pay rock to the chutes, their lights flickering like June Bugs in the darkness while the deafening thud of drills eating their way into the face and roof of the chamber gave a Gulliver effect to the place.

But the vault on level No. 4 was by far the most impressive sight of the day. Here in one place the ore had been removed to a height of 60 feet from the chute to the ceiling and for the matter of 150 feet in diameter, and as one looks down into the hollow and across at the bobbing lights of the miners on the farther side, it has the appearance of a vast underground theatre, dimly lighted and weird. Senator Hubbard suggested it would be a good place for the next Legislature to meet.

After inspecting the engine room at the mouth of the mine tunnel where the new 750 h. p. Ingersoll-Rand engine, "running as smooth as a watch" and fed from the power 12 miles away, furnishes the compressed air and retransmission for the hoists, etc., the party descended to the mess house and partook of a nicely prepared dinner.

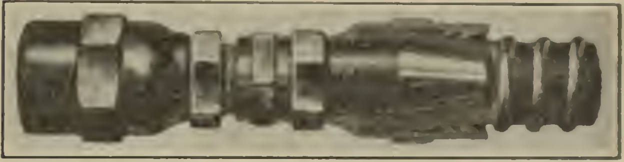
[It will be remembered that in our April issue, page 7575, we showed the big air cylinder of the compressor above referred to, mounted on a truck and drawn by ten heavy horses.—Editor C. A. M.]

Senator Aldrich directed his remarks to a comparison of the home-like atmosphere of the Alaska-Juneau mess house with that of one at a mining camp at Berner's Bay in the early days, saying that he noticed that the waiters were able to serve the table here with slippers on their feet, while at the camp he had reference to, the men sat at the table with their slickers on, the water dripping from the ceiling into the soup and beans which the waiters in gum boots served to them. Representative Moran enlivened the after-dinner smoke by reciting "The Kobuk Maiden,' a poem with an Arctic tang ending, "And the waters of the Kobuk rippled onward to the sea."

Prof. Cory gave a very interesting discourse on the present application of machinery to mining in particular and the work of the world in general, stating that its development had now reached such a stage that "Co-operation is the whole story with the water falls of nature doing the work—one continuous horse power being equal to that of 90 men."

Returning to the mill, the party, guided by Mr. Bradley, Supt. Richards and Foreman White, were shown the minute workings of its fifty stamps, which work up 600 tons per day and watched the black sand which carries the gold dripping off of the broad shakers.

Descending the path to the office, the sightseers visited awhile there, and were then carried to the ferry landing on the company gas boat.



A NEW COUPLING FOR AIR HOSE

The half-tone, made partly in section, shows the essential features of a coupling for rubber hose put out by the National Hose Coupling Company, Peoples Gas Building, Chicago. Scarcely a word of explanation is required. The end of the hose is slipped over the conical end of the nozzle as shown and then the sleeve or socket is drawn over it by the screw movement, causing the hose to hug the cone and make a joint tight and secure. The only tool required is a wrench.

THE HABITS OF THE WINDS

Thirty-five years ago, while making a four months voyage, I was frequently impressed by the unerring accuracy with which Captain Crosby, one of the best known captains sailing from New York, forecast the state of the weather. In reply to my question, he answered: "Doctor, as a result of fifty years of seagoing life, I can assure you that almost invariably, I might say without exception, the wind in its shifting follows the course of the hands of a clock, that is, from left to right Of course," he added, "one cannot say how long the wind will remain in any one quarter, but when it changes it will, almost without exception, take the course I have stated. For instance, if the wind is in the northeast, instead of going to the north and then to northwest, it will on the contrary go over to the east, southeast, south, sotuhwest, west, and finally reach the northwest." When I asked him why that should be he said he had never been able to obtain an answer to that, but that it was an absolute rule as far as the experience of his life went.

One other observation I have made through all these years, although it is not by any means as exact as the first, is that the winds have a fairly accurate length of time in which they remain in their various quarters. For instance, northeast and east winds are generally two or three days in duration, gradually shifting to southeast and south, then after a day's interval, or less, reaching west and northwest. These remarks apply only to the Atlantic Coast and contiguous states, and are inapplicable to the Pacific where the conditions, in some respects even more remarkable, are entirely different.—*Dr. Frank S. Abbott in N. Y. Times.*

FLEXOID AIR CONVEYERS IN TUNNELING

In starting the building of the Mill Creek sewer, which is an extensive tunnel job, at St. Louis, galvanized iron ducts were provided for ventilation in the shafts and headings. On account of the time lost in re-extending the pipe to the headings after shooting, the contractors, Thomas Connor & Sons, took up with the Bemis Bros. Bag Co., the question of supplying a flexible textile conduit. The result was a duct or tube of heavy rubberized fabric practically air-tight and water-tight, strong enough for the light air pressure, light enough to be easily and quickly handled and much cheaper than the galvanized iron.

It is made in sizes up to 24 in. diameter and normally in lengths of 100 feet with handy iron couplings. At the job spoken of there is a Jeffrey blower delivering 10,000 cu. ft. of air per min. A 24 in. Flexoid tube carries the air down the shaft, and 16 in. tubes run each way to the headings. D. H. Blanks, engineer for the contractors, estimates that just before shooting, the blower having been stopped, one man can roll up the duct for 200 ft. or more in a minute or two and that it can be replaced again even more quickly after the shooting. The Flexoid duct has been in use at St. Louis for 5 months and some of it has already been replaced on account of more or less rotting. It is considered that in dry work the life would be much longer. By the time the job is finished the entire duct may have to be replaced once, but even then the cost would be less than one-half of the cost of the galvanized pipe, besides the greater convenience and the saving of time in handling.

NOTES

A 4-in. gas main, 4000 ft. long, was recently welded at Newbern, N. C., with Prest-O-Lite gas and oxygen. The material used was standard National steel line tubing and was sent to the job with the ends beveled and ready for welding. The work was done in the trench, as it was found that faster welds could be made, joints being made in 7 to 10 min. A record of 15 joints with one torch in one afternoon was made, the apparatus being moved a distance of approximately 20 ft. after each weld. Soft steel wire of No. 8 gauge was used as a filling material.

The number of sailors who have been drowned when British warships have been sunk by submarines has caused the Admiralty to adopt a special life preserver. The device is a pneumatic collar, which each sailor wears about his neck at all times when within reach of the enemy. Ordinarily it is not inflated, and so is not in the way, but in case of mishap the wearer may place his lips to the valve mouthpiece and blow the collar full of air in a quarter of a minute. This simple device would seem to be a valuable one although evidently cheap, and should be on sale for the general public.

According to the decision in a recent suit in a West Virginia court, gasoline vapor is not a gas. The lessees under an oil and gas lease perfected a method for condensing, saving and marketing the gasoline that was wasting from the casing-head in the form of vapor, and tendered to the lessors the stipulated royalty based on oil extraction. The lessors claimed in addition thereto the minimum gas rentals, basing their contention on the theory that the gasoline-vapor was a gas product. The court held that gasoline-vapor was not gas within contemplation of the lease, and that the lessors were entitled to royalties based on its production as a part of the oil yield of the well.

A recent application of Prest-O-Lite gas in combination with oxygen for cutting steel work was at the drawbridge of the Florida East Coast Railway, over the St. John's River at Jacksonville, Fla. In the construction of this bridge sheet steel piling having a $\frac{3}{8}$-in. web and approximately $2\frac{1}{4}$ in. thick on the lock joint was driven to form the protection piers. Approximately 860 ft. of this piling had to be cut off at a uniform height and at the lock joint practically four sections of metal had to be cut through. This necessitated frequent changes in the adjustment of the blowpipe. One man did the cutting and between 40 and 50 ft. of piling was cut in 7 hr.

The change-house at the Raritan Copper Works, Perth Amboy, contains a main ventilating-pipe that is fixed along the centre of the building. Branches from it run to, and underneath, each lot of lockers. By this means it is expected that the lockers will be kept thoroughly ventilated, and in wet weather the damp clothing will be dried.

One of the air compressors at a works where I was employed had its intake in the engine room. The engineer was ordered to extend it outside in order to get it away from the heat and moisture. He did this next day, placing it immediately over the exhaust from a small non-condensing engine.—*Power.*

A flash of lightning during a thunderstorm is credited with causing an explosion in a mine shaft in South Africa which killed and injured several people. According to the report on the case, the foreman in charge of sinking the shaft had connected up his wires preparatory to a blast at the bottom of the shaft, and with his helper was being hoisted from the shaft, when the charges exploded and the two men were thrown out at the top. It is supposed that a flash of lightning during a severe thunderstorm that was raging struck the hoisting or guide ropes, by which the electricity was conducted down the shaft to some point where contact was made with the wires connected with the explosives.

The Navy Department has awarded to the International Oxygen Company, 115 Broadway, New York, the contract for the erection of a hydrogen generating plant for ballooning purposes at the aeronautic station of the navy yard at Pensacola, Fla. The company has also received the award from the Government for the installation of its system for generating oxygen and hydrogen at the navy yard at Washington, D. C.

It is estimated that six and a half million people are employed in the whole world in mining and quarrying, about one-third of them being in the British Empire. Thus digging for minerals is one of the chief industries of men, and compressed air is in this line the most active agent employed.

In 1912, the latest year for which detailed figures are available, the world produced about $480,000,000 worth of gold, the British Empire contributing sixty-one per cent. Australia produced ten per cent., South Africa nearly forty per cent. and Canada, the Gold Coast, India, Rhodesia and New Zealand combined, eleven per cent.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 6.

1,144,990. PULSATORY PERCUSSIVE DRILL. Lewis Condict Bayles, Easton, Pa.

1,144,996. WHEEL. John Archie Borland, Cincinnati, Ohio.

1,145,043. PRESSURE-CONTROLLED VALVE. William F. Treiber, Corning, and Emery L. Bulkley, Painted Post, N. Y.

1,145,044. BRAKE-CONTROL VALVE. Walter V. Turner, Edgewood, Pa.

1,145,045. EMERGENCY - VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

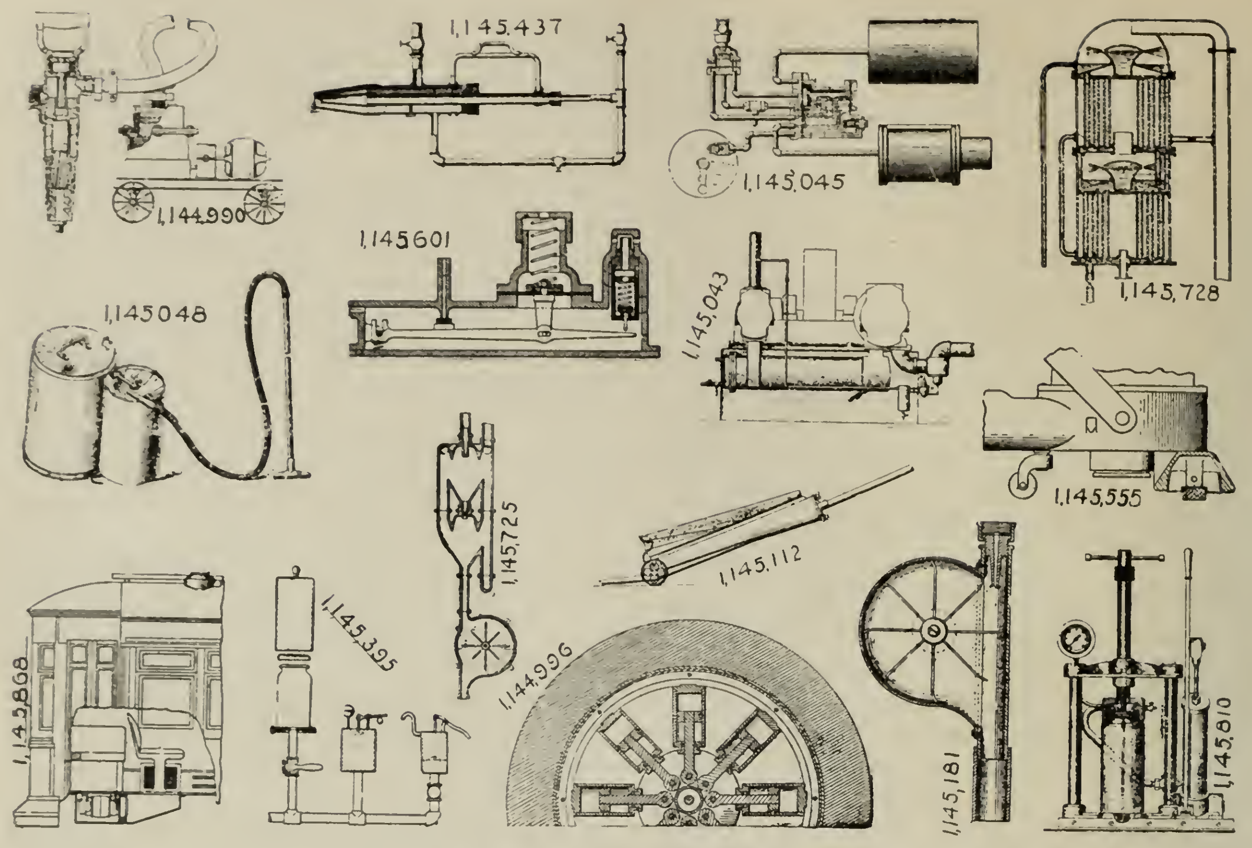
1,145,047-8. VACUUM CLEANING APPARATUS. Theodore Wiedemann and Joseph H. Templin, Philadelphia, Pa.

1,145,112. VACUUM CLEANING-MACHINE. George Brand, Brooklyn, N. Y.

1,145,144. ELASTIC - FLUID TURBINE. Franklin P. Jackman, Marshfield, Oreg.

1,145,181. VACUUM-PUMP. Charles Brent, Buffalo, N. Y.

1,145,276. PNEUMATIC PAD FOR PRINTING-PRESSES. Charles A. Sturtevant, Plainfield, N. J.



Pneumatic Patents July 6.

1,145,395. APPARATUS FOR PRESERVING BY VACUUM. James R. Werth, Richmond, Va.

1,145,437. OIL-BURNER. Sid Perry and Charles A. Kenworthy, Tenino, Wash.

1,145,555. VACUUM-CLEANER. George Clements, Chicago, Ill.

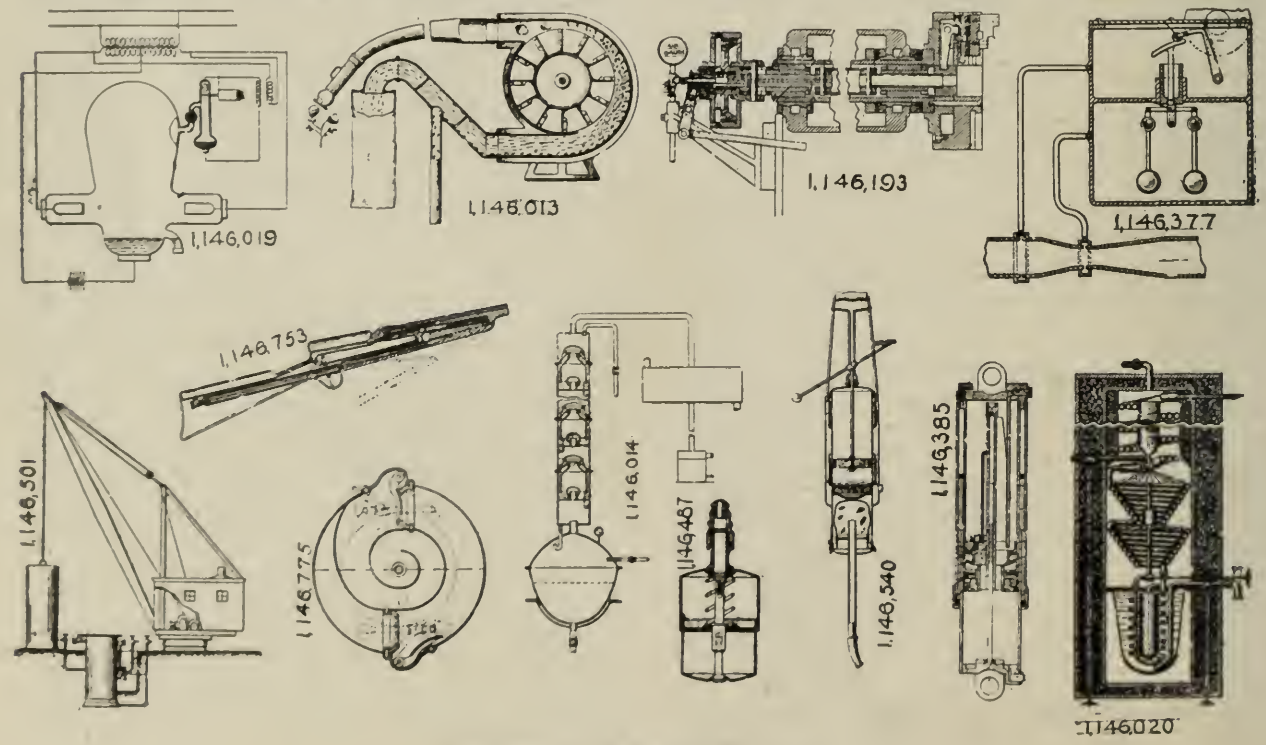
1,145,601. PRESSURE-REDUCING VALVE FOR GAS. Louis Lemoine, Paris, France.

1,145,725. VACUUM-CREATING DEVICE. George C. Weiss, Pittsburgh, Pa.

1,145,728. EVAPORATING APPARATUS. Wilhelm Wiegand, Merseburg, Germany.

1,145,810. DOMESTIC VACUUM-SEALER. George Brown Sinclair and Silas E. Menough, Wellsville, Ohio.

1,145,868-9. CAR-VENTILATING SYSTEM. Dwight I. Cooke, Chicago, Ill.



Pneumatic Patents July 13.

JULY 13.

1,145,948. WATER-COOLED BLOWPIPE. Adolph W. Waern, New York, N. Y.

1,146,013. PROCESS OF PICKING AND SEPARATING COTTON FROM BOLLS. John Meier, Dallas, Tex.

A process of separating cotton from its burs consisting in causing bodily the bur with the cotton still attached thereto to be detached from the stem of the plant and driven forcibly *by pneumatic means* against a roughened convex surface separating the fiber from the burs by attrition between said surface and a revolving element, causing further downward movement of the burs and fiber by the combined action of the blast and revolving element and separating the burs from the fiber by action of gravity during such movement, and finally depositing the fiber and burs in separate receptacles.

1,146,014. METHOD FOR CONCENTRATING NICOTIN SOLUTIONS. Robert G. Mewborne, Louisville, Ky.

1. The improvement in processes of concentrating solutions or extracts containing free nicotin, which consists in distilling the water off in a chamber mantained under a *high vacuum* and the corresponding low temperature to the desired point of concentration.

1,146,019. VACUUM-PRODUCING METHOD AND MEANS. August H. Pfund, Baltimore, Md.

1,146,020. AIR LIQUEFIER AND SEPARATOR. James F. Place, Glen Ridge, N. J.

1,146,193. FLUID-PRESSURE CHUCK-ACTUATING DEVICE. William L. Miller, Madison, Wis.

1,146,202. ANEMOMETER. Alec Ogilvie, Eastchurch, Sheppey, England.

1,146,284. AIR AND WATER BLOWPIPE FOR ROCK-DRILLING. Frank T. Sanders, Colorado, Springs, Colo.

1,146,335. FLUID-PRESSURE DEVICE. Richard Liebau, Watervliet, N. Y.

1. The combination with members having a sliding joint therebetween and forming a chambered device capable of movement for compression and extension, of liquid and gaseous fluids within the chamber, and a pump within said chamber having mechanical connection with both of said members for transferring leaked liquid to said chamber.

1,146,377. FLUID-METER. Benjamin M. Walpole, Providence, R. I.

1,146,409. FLUID-METER. Harry S. Dolbey, Providence, R. I.

1,146,487. AIR-COMPRESSION PUMP. Henri Albin Joseph Evesque, Valence, France.

1,146,501. IMPREGNATING PILES. Harry G. Jennison, Toledo, Ohio.

1,146,526. DEVICE FOR CONTROLLING FLUID-PRESSURE. Daniel Scanlan, St. Louis, Mo.

1,146,540. VACUUM-CLEANER. John M. Winter, Reading, Pa.

1,146,753. AIR-GUN. Arthur V. Dickey, Seattle, Wash.

1,146,775. APPARATUS FOR PNEUMATICALLY DELIVERING MATERIAL. Gilbert H. Gilbert, New York, N. Y.

JULY 20.

1,146,781. SUBMARINE ARMOR. Harry L. Bowdoin, Bayonne, N. J.

1,146,870. DRILLING-MACHINE. Charles H. Haeseler, Philadelphia, Pa.

1. In a drilling machine, the combination of a drilling engine including a cylinder, a hammering piston reciprocable therein, a rotatable tool holder at the front end of the cylinder, a back head for the cylinder, a rotary motor mounted in the back and reduction gearing between the motor and tool holder.

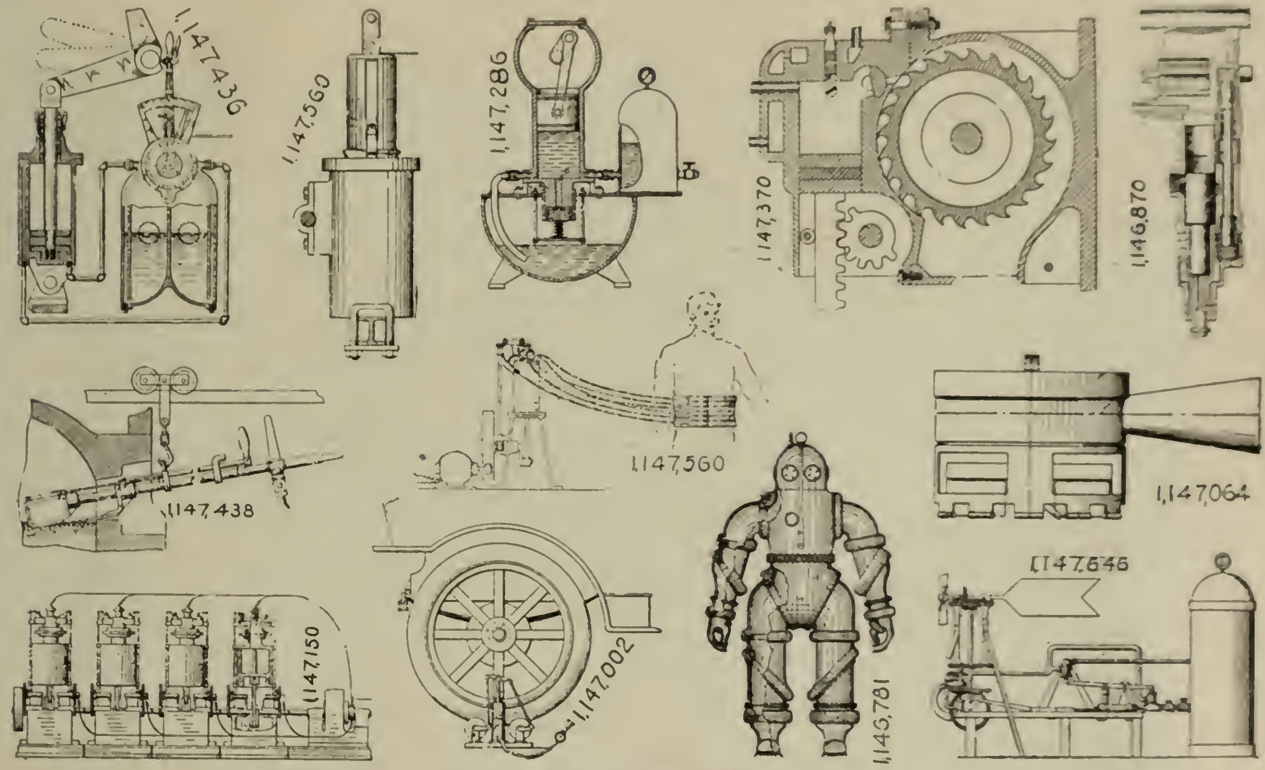
1,147,002. AIR-PUMP. Thomas S. Causey, Dallas, Tex.

1,147,064. VACUUM BLACKBOARD-ERASER. Miles V. Wolf, Ashland, Ohio.

1,147,148. AIR-CUSHION. Charles I. Dickerson, Duchesne, Utah.

1,147,150. METHOD OF OBTAINING OXIDS OF NITROGEN FROM ATMOSPHERIC AIR. Francis I. du Pont, Wilmington, Del.

1. The hereinbefore described method of producing oxids of nitrogen from mixtures of oxygen and nitrogen which consists in isolating



Pneumatic Patents July 20.

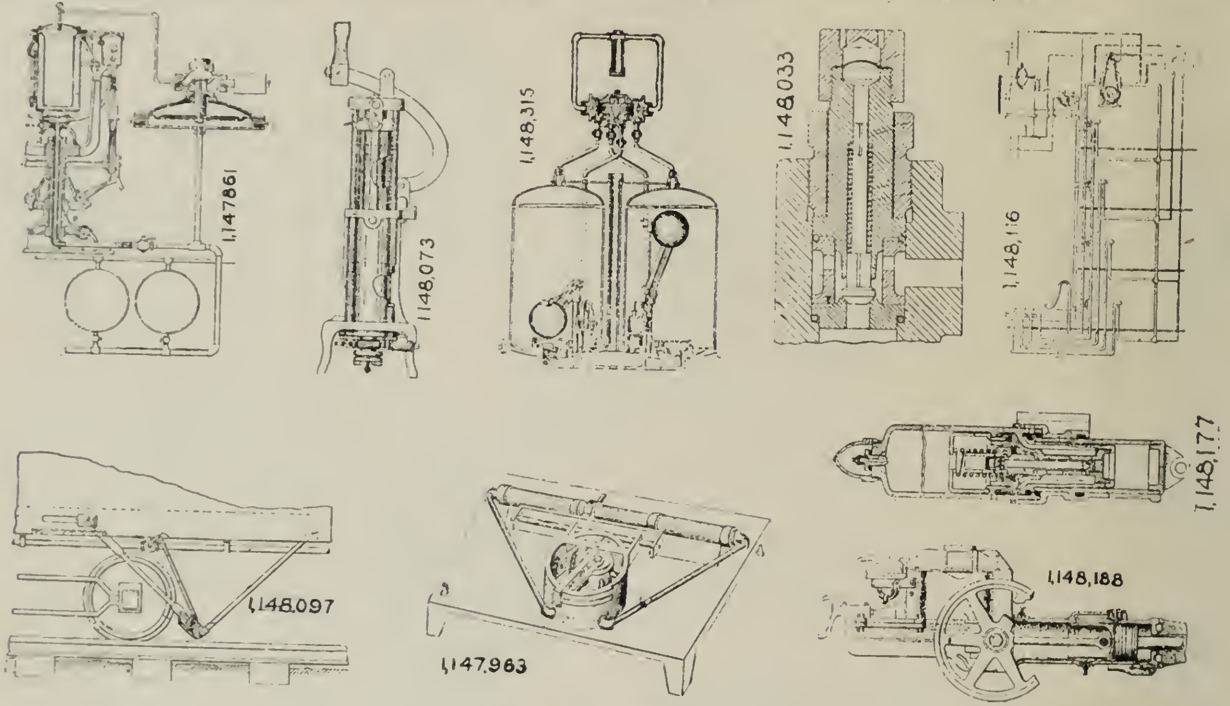
successive and independent quantities of the mixed gases and within a space having considerable length relatively to its diameter, subjecting each volume of mixed gases to the influence of an electric arc, drawing out the arc in the lengthwise direction of extension of said volume of mixed gases, proportioning the amount of current in the arc to the diameter of said volume of mixed gases so as to effect a substantially instantaneous heating of the latter to a high temperature and simultaneously therewith converting the heat into mechanical energy.

1,147,242. AUTOMATIC BRAKE-RELEASER. Edward O. Hentschel, Cincinnati, and William F. C. Harting, Elmwood Place, Ohio.

1,147,265. PRODUCTION OF OZONE. John Robert Quain, London, England.

1,147,286. SPRAYER. Fred S. Welch, Pontiac, Mich.

1,147,370. INTERNAL-EXPLOSION ENGINE. Conradin Alfred Breitung, Seattle, Wash.



Pneumatic Patents July 27.

1. In an engine, in combination, a main or power developing rotor, a preliminary-air-compressing chamber and a rotor therein connected to and rotating with the main rotor, a final-compression cylinder and a piston therein operated from the main rotor, a valve between said cylinder and the preliminary-air-compressing chamber, a valve between said cylinder and the main rotor, and means for operating said valves from the main rotor.

1,147,436. HYDROPNEUMATIC LOCOMOTIVE REVERSING-GEAR. Eugene L. Ragonnet, Langhorne, Pa.

1,147,438. VACUUM-OPERATED GLASS-LADLE. Solon O. Richardson, Jr., Toledo, Ohio.

1,147,560. MASSAGE APPARATUS. Frank Shurtleff and Wilfred Shurtleff, Moline, Ill.

1,147,646. AIR-COMPRESSOR. William F. Robbins, Scranton, Pa.

JULY 27.

1,147,820. ELECTROPNEUMATIC SWITCH. William M. Scott, Philadelphia, Pa.

1,147,861. PACKAGING LIQUIDS. Frank Hennebohle, Chicago, and Gerhardt J. Patitz, Oak Park, Ill.

1. In a liquid filling machine, the combination of a filling tank connected with a source of liquid supply; filling mechanism connected to said tank; and means for supplying gas under pressure to said tank and to a container to be filled, said means comprising hydraulic means for maintaining a constant excess pressure on the liquid entering said container over the gas pressure in said container.

1,147,963. RECIPROCATING FLUID-MOTOR. Walter J. Meiluk, Hamilton, Ontario, Canada.

1,148,025. AIR-RELEASING APPLIANCE FOR SIGNALS, SWITCHES, AND THE LIKE. Cleburg Wesley Killian, Oakland, Cal.

1,148,033. PUMP OR COMPRESSOR. Ernest William Herbert McMichael, Waltham Cross, England.

1,148,073. AIR-PUMP. Peter Jacob Bode, St. Louis, Mo.

1,148,077-82. PNEUMATIC AMMUNITION ELEVATING AND LOADING DEVICE. James T. Cowley, Boston, Mass.

1,148,097. EMERGENCY AIR-BRAKE APPLIANCE. Fortes M. Kleckner, Drumright, Okla.

1,148,116. PNEUMATIC-DESPATCH-TUBE APPARATUS. John T. Needham, Bayonne, N. J.

1,148,177. VEHICLE AIR-SPRING. Richard Liebau, Swissvale, Pa.

1,148,188. PRESSURE DEVELOPING AND DRIVEN TOOL. Alexander Palmros, Syracuse, N. Y.

1. A reciprocating tool comprising fluid pressure developing and driven members, a common cylinder for said members, a fluid pressure storage chamber situated to receive fluid under pressure from said pressure developing piston during its forward stroke, a valve controlled intake port and a discharge port, said pressure developing member having a rearward extension for closing said discharge port during the greater part of its stroke, said ports establishing communication between the cylinder of said members and said storage chamber.

1,148,310. PNEUMATIC TOOL. George H. Gilman, Claremont, N. H.

1,148,315. HYDROPNEUMATIC PUMP. Benjamin S. H. Harris, Greenville, S. C.

1,148,371. PNEUMATIC FEEDING MECHANISM FOR BRANDING OR PRINTING MACHINES. Orin C. Fenlason, Hoquiam, Wash.

1,148,376. PNEUMATIC INSOLE. Samuel S. Gay, Sedro Woolley, Wash.

COMPRESSED AIR
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EVERYTHING PNEUMATIC.

Vol. XX OCTOBER, 1915 No. 10

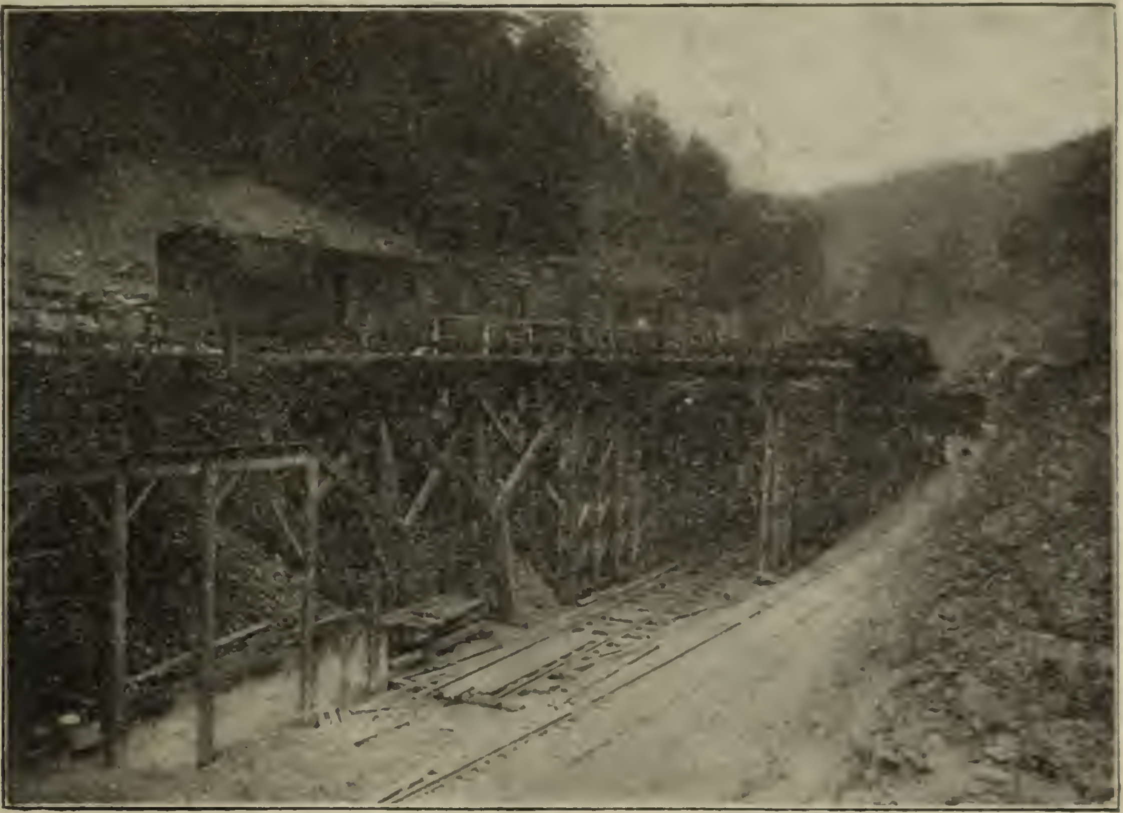

FIG. I. LOADING AND STORAGE TRESTLE. TUNNEL ENTRANCE IN BACKGROUND.

THE LINING OF SANDY RIDGE TUNNEL

BY ORLANDO K. MORGAN.

The Carolina, Clinchfield and Ohio Railway has recently completed and placed in operation that portion of its line known as the Elkhorn Extension, thus extending the line from Dante, Va., to Elkhorn City, Ky., the terminus of the Big Sandy Division of the Chesapeake and Ohio Railway. Where the above extension passes under the divide known as "Sandy Ridge" just north of Dante, Va., there is a tunnel, single track, 7,804 ft. long. This tunnel passes for about one-half its length through slate and shale formations which disintegrate upon exposure to air, and the remaining half through sandstone formation badly seamed and broken. In view of these conditions, the management decided to promptly begin the lining of the entire tunnel with concrete.

This work would require the placing of between 50,000 and 60,000 cu. yds. of concrete, all of which would have to be done while traffic was passing through the tunnel.

In addition to Sandy Ridge there are a number of other tunnels on the above exten-

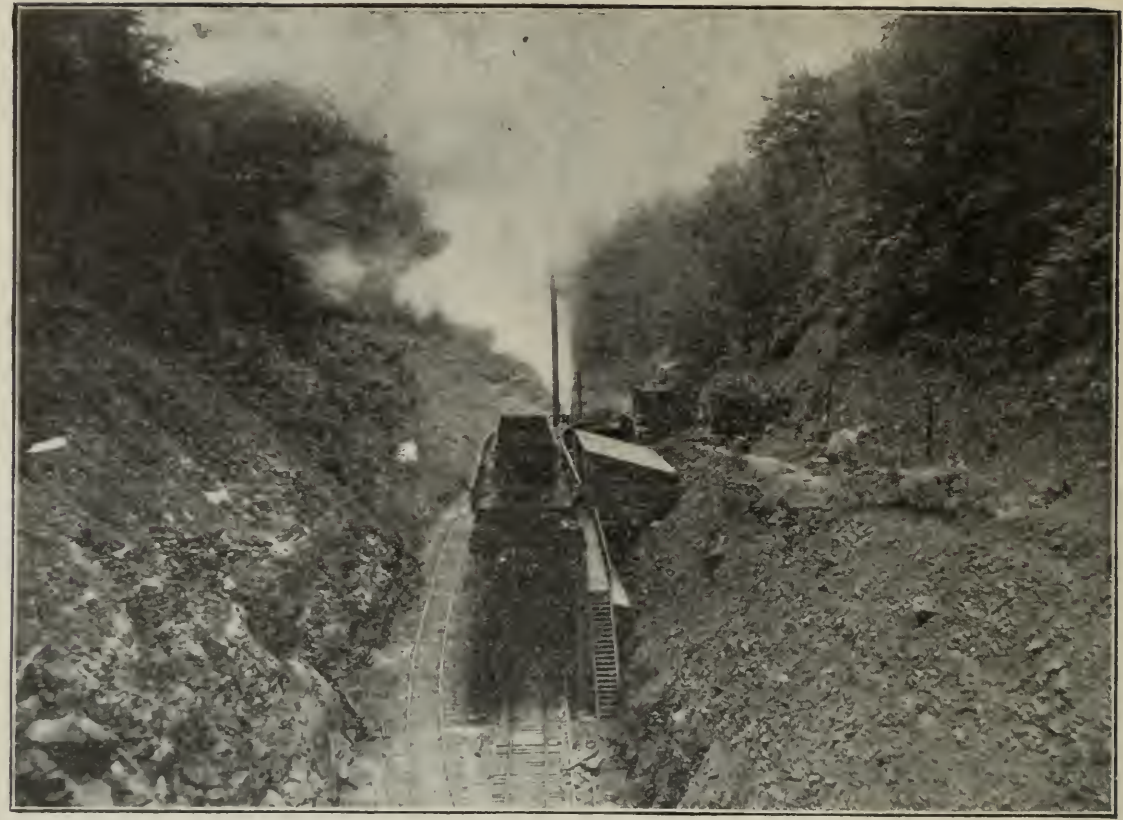

FIG. 2. TRESTLE FROM SOUTH PORTAL.

sion as well as on other portions of the road which may require lining in the future under similar conditions of traffic. With this in mind the Railway Company engineers made a special study of various plans for the above work by which it could be done with economy and rapidity, also holding in mind that much of the plant would be used for similar work after this particular job is finished.

The result of these studies was the determination to use the compressed air method of mixing and placing the concrete, and to provide for this a plant as follows:

(1) A self-propelled concreting car.

(2) A loading and storage trestle.

(3) Compressed air plant and pipe line through tunnel.

(4) Concrete forms quickly and easily movable.

These features will be described separately.

CONCRETE CAR.

On account of the great length of the tunnel it was deemed impracticable to furnish the concrete from a mixer located at either portal.' It was concluded at the outset that the mixing could be done inside the tunnel where the concrete was to be deposited, and the conclusion was that a car carrying the ingredients would be the proper solution. It also appeared most desirable, if not absolutely necessary, to handle the car without filling the tunnel with smoke. These premises led to the idea of a concreting car self-propelled and finally to the gasoline engine as most nearly fulfilling all conditions for the propelling device. A gas engine would emit only a small amount of smoke or gas while moving and could be shut off entirely when position was taken. It occupies but small space and can be operated by one man, and, contrary to general belief, it is very reliable. To obtain capacity, gravity flow of materials, and a convenient and desirable arrangement, the car must be made as large as the standard clearance of the road would permit after allowing room for concrete forms. The dimensions are 40 ft. long over end sills, 10 ft. 4½ in. wide over braces, and 17 ft. 9 in. from top of rail to top of car. It was decided to build it of steel as the material bins are high above the rail and the weights considerable.

The principal features of the car are:—

A central chamber, open on the sides, 8½ ft. long, 9 ft. 8 in. wide, and 10 ft. 3 in. high, in which is located on one side the concrete (pneumatic) mixer and on the other side the charging skip. Over this chamber is a water tank of 1850 gallons capacity. This tank furnishes water for the concrete and is also connected with the cooling system for the gasoline engine. Facing the central chamber is the stone bin (30 cu. yds. capacity) on one end and the sand bin (12 cu. yds. capacity) on the other. Each bin has a chute 20 in. wide leading to the charging skip, and each chute is controlled by an under-cut gate. Under the stone bin is space occupied by a 96 cu. ft air receiver standing vertically, and also space for storage of cement in bags and protected from water by the bin overhead. Under the sand bin is the gasoline engine and its auxiliary equipment completely housed from water and dust. The charging skip in its lower position stands its top rim about 1 ft. 3 in. above the floor, and it travels on inclined guide rails (40 lb. Tee rails) to its upper position over the mixer, being hoisted by a compressed air cylinder $9\frac{1}{4}$ in. diameter. The gate of the skip works automatically by means of a guide rail. The mixer is for a two-bag batch (4-10 cu. yd.) and has its 8-in. outlet pipe at the bottom running horizontally and curving to the outside of the rear truck and thence vertically to near the top of the car, where it branches by means of a wye into two lines, one a 180-degree bend to the rear for "shooting" in foundation and sidewall and the other going to the roof for "shooting" into the arch. The wye is a special patented device with a sliding plate controlling the movement of material into either arm. The arrangement of the pipe, traveling with the car and being in position at all times for "shooting" concrete, is an important one in saving time and expense. One of the difficulties of many jobs where the pneumatic mixer has been used was the handling of the big heavy pipe.

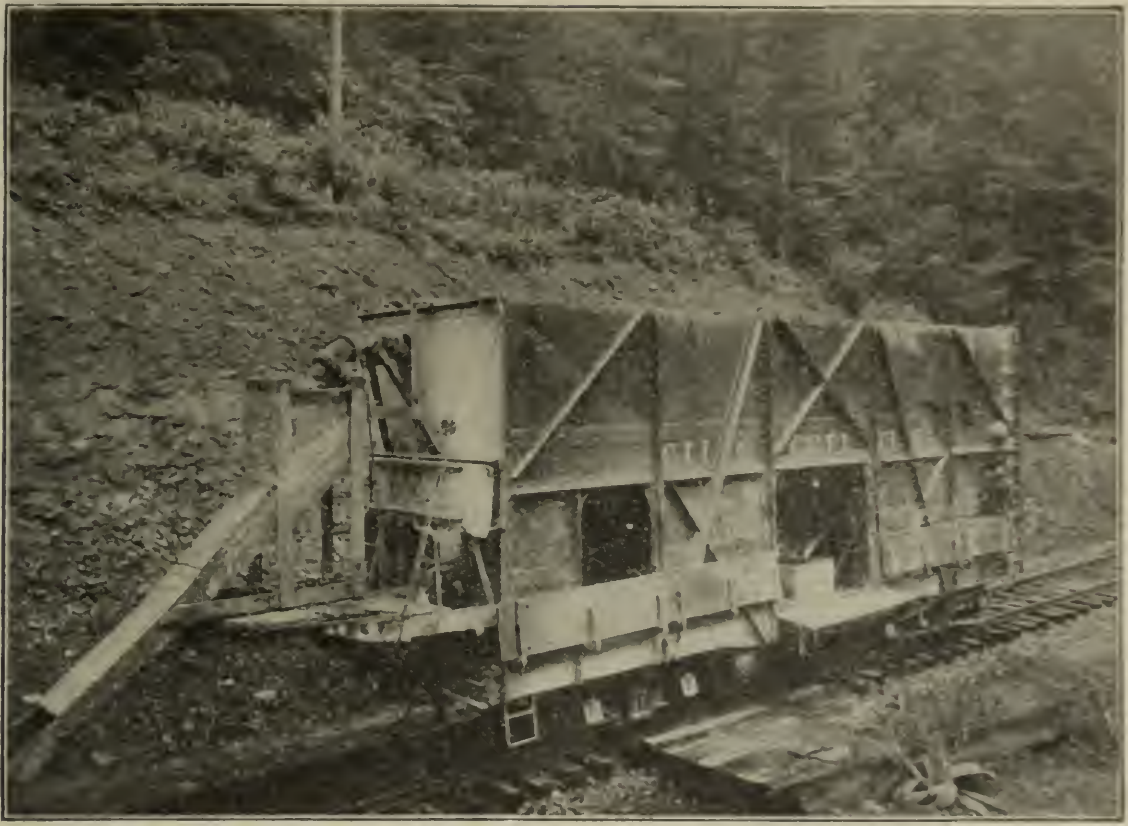

FIG. 3. CONCRETING CAR. CENTER OF SIDE PLATFORM IN WORKING POSITION.

Along one side of the car is a folding platform 2 ft. wide level with the main floor. This is used by the men carrying cement and to get to and from the engine room, during the ordinary work of the car this platform remains down.

The entire arrangement is compact and with a view of saving manual labor. One man controls the hoisting of skip, injection of water, and mixing and discharge of the batch

One man is placed at each chute and two men carry, open, and empty the cement bags.

The gasoline engine is of the six-cylinder four-cycle Tee head type and rated 200 H. P. at 350 r. p. m. It can be throttled to 125 r. p. m. The motor and its frame constitute one of the trucks of the car. The cylinders stand in a row at right angles to the track and the whole construction is compact but accessible. It is started by compressed air being admitted to three cylinders, then the explosion of the gasoline takes place in the other cylinders and continues the motion. The transmission is by means of a Morse chain on to the driven axle (one only being used) and the control is through a friction clutch of special design. The general principle employed is much the same as in the ordinary automobile. The car and gasoline engine were built by the McKeen Motor Car Co., of Omaha, Nebraska. It was sent knocked down and was erected at the Railway Shops at Erwin, Tenn., and moved to the work (105 miles) under its own power at a speed ranging at times as high as 25 miles per hour. The mixer was installed and the piping done on the car by the Pneumatic Placing Company of 45 Broadway, New York City.

LOADING AND STORAGE TRESTLE.

This is of special design and so arranged that the above car goes under it and receives stone (crusher run), sand, cement (in bags), and water, all by gravity and frequently all at the same time. The sand and stone is drawn from overhead bins by means of under cut gates. Cement is conveyed into car by a chute. The trestle has a track over its deck upon which stone and sand in hopper cars is stored or unloaded into the bins below. There is a continuous row of 27 bins with an aggregate capacity of 324 cu. yds. and total length of 162 ft., and five loaded cars can be stored over these bins, giving a storage of 200 cu. yds. in addition to the above. The trestle is built of timber and attention is called to the unusual arrangement of posts and bracing.

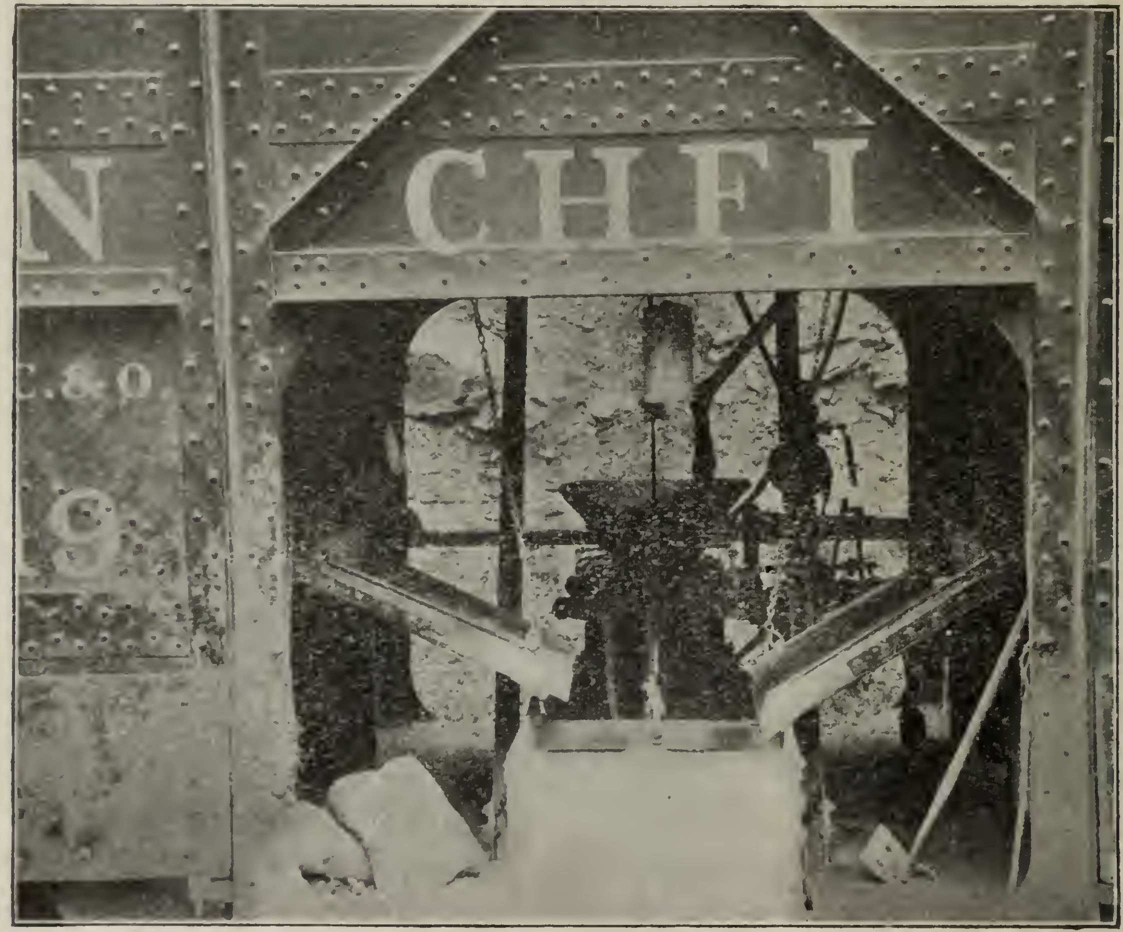

FIG. 4. WORKING CHAMBER OF CAR.

COMPRESSOR PLANT AND PIPE LINE.

The compressor plant is exceptional for a temporary outfit. To save money on foundations and at the same time increase the space, the floor level of boilers and compressors was fixed 4½ ft. above sub-grade and the concrete foundations and rim walls were built up to this height and the space underneath utilized for water tanks and ash pit. The building is of 1 in. boards covered with tar paper. The arrangement chosen permits coal to be dumped from cars on trestle above described to a pile in front of the boilers. There are two boilers, both locomotive type, one new 150 H. P., one old 70 H. P. They are so connected by piping that either one can be cut in or out of service for cleaning or repairs. Two compressors are installed but an extra foundation for another unit is provided, the reason for which appears elsewhere. The compressors are alike and of the Ingersoll-Rand R. R. I. Rogler Valve class. This is a high speed, single stage, modern type compressor. Steam cylinder 12x12, air cylinder 12x14, piston displacement, at 250 r. p. m., 528 cu. ft. and actual output about 375 cu. ft. of free air per minute each, or 750 cu. ft. for both. They work under 125 lbs. steam pressure and compress air to 115 lbs. They are cooled by water brought by gravity from an old coal mine mouth From the compressors a 6-inch pipe leads to a 150 cu ft air receiver and thence a 4-inch pipe line goes on a steady 0.5 per cent down grade entirely through the tunnel At the lower end is a pet cock to draw off any water. In order to care for expansion and contraction the pipe line is laid alternately on the east and west sides of the track in lengths of about 1,000 ft. connected by curves of 2 ft. radius. The bottom of the pipe is at level of bottom of ties and distant 1 ft 0 in. from end of ties. About every 100 ft a long radius tee is placed and about 20 mine cocks of 4-inch size are provided; these can be shifted to the various tees as the progress of the work demands. From the mine cock a 3-inch hose connects with the 96 cu. ft. air receiver on the car. The arrangement thus being that by means of a hose 60 ft. long the car can be connected to the 4-inch pipe line at any point at which it may stop and receive an ample supply of air.

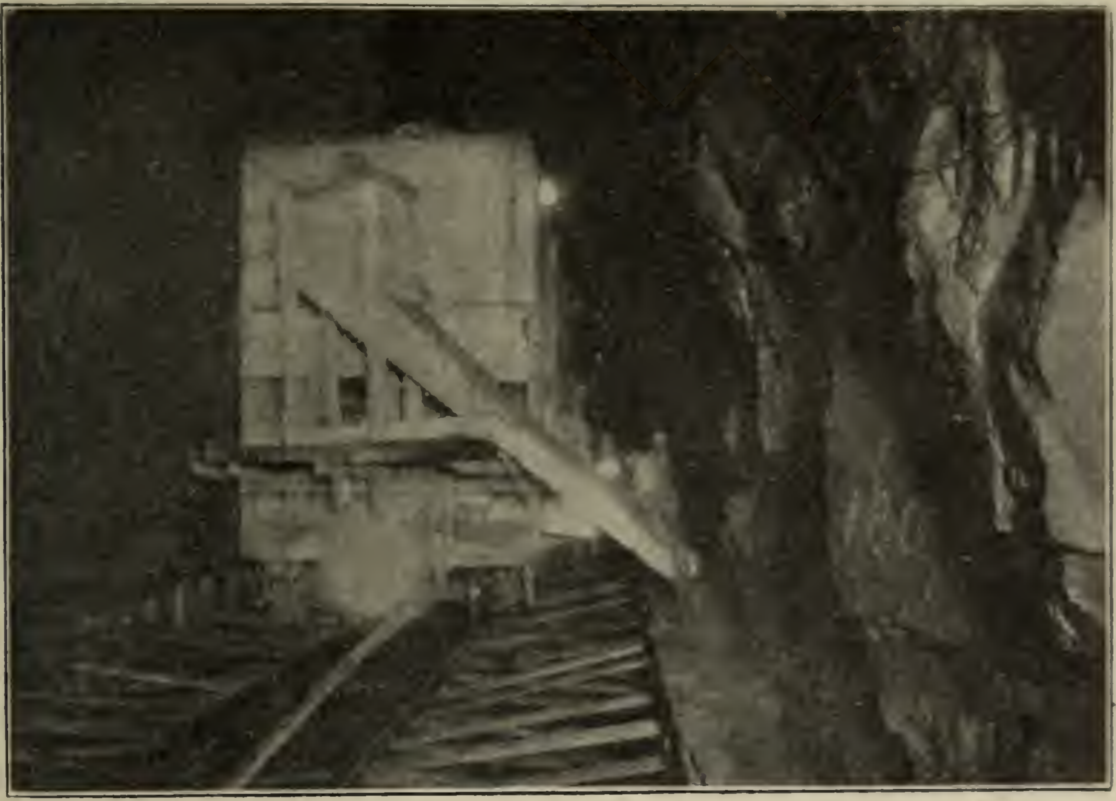

FIG. 5. FLASHLIGHT OF CONCRETE WORK IN TUNNEL.

FORMS.

The forms are of steel except the arch ring, which is 3-inch hard pine on steel ribs. They are of the Blaw collapsible type but of exceptionally stiff design. They are held by anchor bolts to the walls of the tunnel and are without interior bracing, rods or struts, so that the concreting car as well as trains may pass without interruption. They are collapsible by inserting temporary rods, which are removed after this is done. Five 30-ft. sections are provided, and it is expected the car will fill at least one section each day and lose no time waiting for the moving of forms or for concrete to take its set. For the foundations and initial bench wall, wooden forms are in use. They are made in sections of 12 ft. and braced from the track and are taken down and carried ahead and re-used as required.

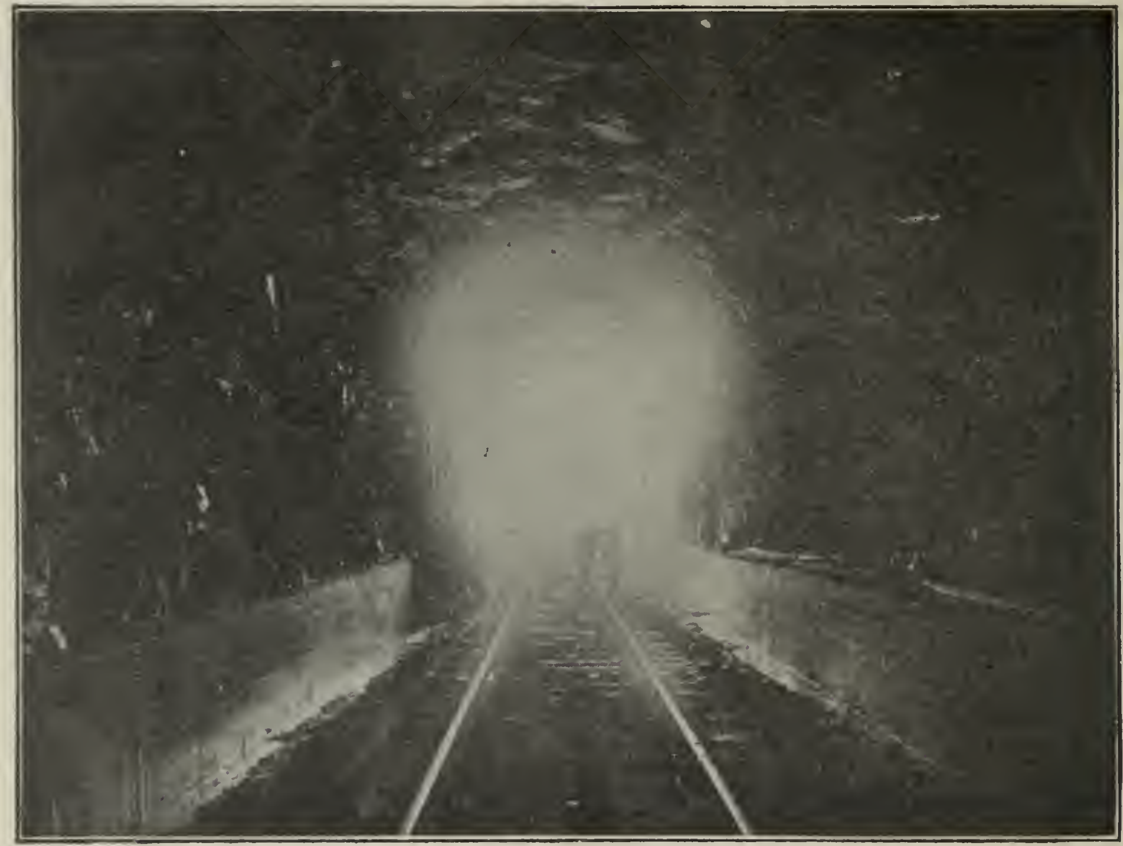

FIG. 6. LOOKING OUT OF SOUTH END OF TUNNEL.

IN GENERAL.

The car began regular operation in the tunnel on July 9. 1915, and has worked every day since, Sundays excepted, and has steadily increased its output as the men have become more used to the work and better organized, as shown by the following record:

Week ended July 17, 1915, 261 cu. yds.
Week ended July 24, 1915, 379 cu. yds.
Week ended July 31, 1915, 516 cu. yds.
Week ended Aug. 7, 1915, 822 cu. yds.
Week ended Aug. 14, 1915, 928 cu. yds.

Several runs of 180 cu. yds. per day and one run of 201 cu. yds. have been made. The work so far has been putting in the foundation and initial lift of bench wall 4 ft. 4 in. high, which requires moving the car more than will be necessary when "shooting" into the arch form. The performance is, however, largely dependent upon interference from trains passing through the tunnel.

Another feature of this plant is the short pipe through which the charge moves. Generally speaking, it has been held that at least 50 ft. of pipe was necessary to get a good mixture of concrete. In this case it goes through 41 ft. of pipe and 10 ft. of chute and the mixture is good. In several installations concrete has been placed through 1,200 ft. of pipe, and the record for distance to date is 2,805 ft.

One of the difficult problems confronting the designer is to place the charges of ingredients into the mixer fast enough to work it to its capacity. The mixer can shoot a batch every 15 seconds provided sufficient air is furnished. But to give it a charge of material every 15 seconds seems to be an unsolved problem.

Time records of the device here used show the speed at which batches are discharged, giving the actual time the car is coupled to the hose and working inside the tunnel.

Aug. 17, 1915, 423 batches in 381 minutes, average 54.0 seconds per batch.

Aug. 18, 1915, 323 batches in 302 minutes, average 56.1 seconds per batch.

Aug. 19, 1915, 448 batches in 340 minutes, average 45.5 seconds per batch.

Aug. 20, 1915, 325 batches in 250 minutes, average 46.1 seconds per batch.

Aug. 21, 1915, 309 batches in 280 minutes, average 54.3 seconds per batch.

The variation is due to condition of material, whether wet or dry, which affects the rapidity with which it flows in chutes and skip. It is believed the operation can be speeded up to an average of about 35 to 40 seconds with dry material. Observe that the door of the skip automatically opens as the skip reaches to position and closes as it is lowered away from same, also the door serves as a chute while open, also that side slopes are steep and unbroken, so that it can free itself quickly. The material when damp has a decided tendency to arch either vertically or horizontally and frequently this arch must be broken by hand. The hoisting of the skip, the placing of the water, and the discharge of the batch is all controlled by one operator.

The lighting of the inside of the car is by carbide lights and of the outside work by hand torches and carbide lights.

A great diversity of opinion exists among those familiar with the compressed air method of mixing and placing concrete as to the quantities of air required. So far it appears that the present plant with a capacity of 750 cu. ft. of free air per minute is ample for this work, but on account of this difference of opinion provision has been made in the compressor house for the placing of an extra compressor in case it is required. It was found that one compressor alone slowed the work down to a batch in about 1¼ minutes.

The plant was designed by O. K. Morgan, office Engineer, under the general direction of Ward Crosby, Chief Engineer, of the C. C. & O. Ry.

The pressure of the atmosphere in pounds per square inch at any altitude may be closely approximated for ordinary temperatures by multiplying the height of the mercury barometer in inches by 0.491.

INSTALLING AIR LIFT PUMPS

BY A. H. FORD.*

The increasing use of deep wells as sources of water supply for cities in different parts of the country has greatly stimulated the adoption of the air lift. Briefly the advantages and disadvantages of air lifts may be reviewed as follows. They are superior to pumps of other kinds because of the entire lack of moving parts in the well and the large rate of flow which can be obtained by their use. These are especially desirable qualities when one or two wells are depended on to furnish the entire water supply of a town. Opposed to these desirable qualities is the low efficiency of the device. Its use should therefore be limited to those cases where efficiency can be sacrificed for the sake of reduction in maintenance expense, increase in well output or increase in reliabilty.

In general an air lift consists of an air pipe extending a considerable distance below the level of the water in the well and so arranged that the air supplied to it by an air compressor, located at the surface of the ground, is delivered near the bottom of the eduction pipe which carries the mixture of air and water to the point of discharge.

The maximum air pressure required to start a lift to operating is equal to 2.31 times the submergence of the air pipe, in feet. As soon as the lift begins to operate, the pressure is reduced; because of the drawing down of the water in the well, thus reducing the submergence, and increasing the lift. This lowering of the water level may be considerable and is the determining factor in fixing the economical output of a well.

A number of the factors which enter into the efficiency of an air lift must of necessity be determined by experiment on the particular well in question; but some of them admit of generally applicable determinations being made. Among these is the best form of foot piece, as the connection between the air pipe and the eduction pipe is called. There are a number of forms of foot piece on the market, for some of which extravagant claims of efficiency are made; but as wide variations in the efficiency are due to slight changes in

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*Iowa City, Iowa. From paper before Iowa Engineering Society.

TABLE I.—EFFECT OF SUBMERGENCE ON EFFICIENCY OF AIR LIFT AT HATTIESBURG, MISS.

Submergence lift.	Efficiency. Per cent.
8.70	26.5
5.46	31.0
3.86	35.0
2.91	36.6
2.25	37.7
1.86	36.8
1.45	34.5
1.19	31.0
.96	26.5

Flow about 1,100 gals. per min.
Lift about 37 ft.

proportion of other parts of the system or the method of operation, such claims are to be looked on askance, unless they are backed up by adequate guarantees. Tests have shown that the effect of a change in foot piece may be to increase the efficiency as much as 50 per cent. when the head is high, with a much smaller increase when the head is low.

The efficiency of even a well designed air lift is low; varying from 20 per cent for a lift of 600 feet, to 45 per cent for a lift of 50 ft.; and is greatly influenced by the ratio of the submergence of the air pipe to the lift; the best ratio being about 2. This is clearly shown in Table I giving data on a test of a well at Hattiesburg, Miss., as reported in "Pumping by Compressed Air," by E. M. Ivins. In this test, the speed of the air compressor was adjusted so as to keep the rate of flow of water constant, while the length of the air pipe was varied. The dimensions of the well and air lift were as follows:

Total depth of well, ft.	453.5
Inside diameter of casing, ins	9⅝
Inside diameter of air pipe, ins	2½
Inside diameter eduction pipe, ins	9⅝
Static lift, feet	4.0

The results in Table I show that the maximum efficiency is secured when the submergence is 2.5 times the lift and that the efficiency falls off more rapidly for a reduction in the submergence than for an increase. It is a good plan therefore to have the submergence more than that calculated for the best efficiency, rather than less. This allows for the usual occurrence, viz., that the pumping lift increases as more wells are sunk and as the well is pumped more.

TABLE II.—RESULTS OF TESTS TO DETERMINE BEST FLOW FROM DEEP WELLS AT HATTIESBURG, MISS., WITH AIR LIFT.

Length of air pipe (feet).	Flow (gal. per min.).	Lift (feet).	Efficiency. Per cent.	Duty (gals. per hp.-hr.)
224	1,495	47.5	32.6	1,630
208	1,459	45.8	31.5	1,640
184	1,419	44.3	31.1	1,670
162	1,359	39.4	30.0	1,790
142	1,299	37.7	30.6	1,920
124	1,219	37.5	32.8	2,070
105	1,106	37.1	36.7	2,340
86	1,008	32.5	33.4	2,450
79	904	29.3	31.3	2,530
67	802	26.0	30.5	2,750
43	690	21.2	29.8	3,240

Previous to this test the length of the air pipe in this well had been varied with a view to finding out the best flow at which to operate the well. The important data are given in Table II.

The air supply was apparently adjusted so as to get the best efficiency for each submergence.

This test shows an anomalous variation of the relation of lift to rate of flow; which is probably due to the coming into action of a second water bearing stratum, there being two cut by the well, when the level of the water had dropped 35 ft. on account of the operation of the lift.

The writer believes that pump duty, water pumped per unit of energy supply, should be made the criterion of operation rather than mechanical efficiency. He has therefore calculated the last column. This shows that the test was not carried to low enough submergence to reach maximum duty. The duty of this lift would have been increased 42 per cent, and the cost of pumping reduced that amount, had the well been operated at a flow of 700 gals. per minute instead of 1,100 gals per minute. The demand for water might not have allowed operation at this rate in this case, but in general the rate of pumping should not be so high as to lower the water level in the well to such an extent as to seriously decrease the duty.

The Hudson Coal Co. has created the position of Safety Engineer. Mr. R. Y. Williams will fill the position and will devote all of his time to the prevention of accidents. His headquarters will be in Scranton.

THE AIR LIFT FOR COAL MINES

BY S. W. SYMONS.*

The air-lift pump has found its chief field in municipal and private water-supply, and there are many large coal mines using it for such purposes. It has not been used extensively for shaft unwatering and mine drainage, although it is better adapted to such work under certain conditions than any other method of pumping.

Of the many air-lift plants in operation, some are working at a better economy than would be possible with other methods of pumping. As the matter of cost of operation is one that can be determined only after knowing all the working conditions of a given case, economy is often by no means the governing consideration; sometimes reliability and simplicity are of even greater importance, and it is in such cases that the air-lift method excels.

For shaft unwatering, the ease and cheapness of installation, absence of moving parts under water, ability to handle acidulous and foul water and the high rate of discharge from a given size of pipe are obvious advantages peculiar to the air lift.

For mine-drainage work, the great simplicity of the system, the fact that any number of pumps can be operated from one compressor plant and the absence of complicated mechanism in restricted situations underground are its chief recommendations.

A special case of mine drainage where the air lift can be used to great advantage is when water is struck at a low level a long distance from the main pump or shaft—sometimes a matter of a mile or more. Instead of laying long and expensive pipe lines, it is often both cheaper and more satisfactory to install an air lift by putting in a bore-hole from the surface to pass through the workings at or near the low point. With a properly designed air-lift pump it is easy to see that the efficiency of such an arrangement would be considerably greater than the forcing of the water through several hundred feet of pipe to the shaft. Fig. I shows the arrangement clearly.

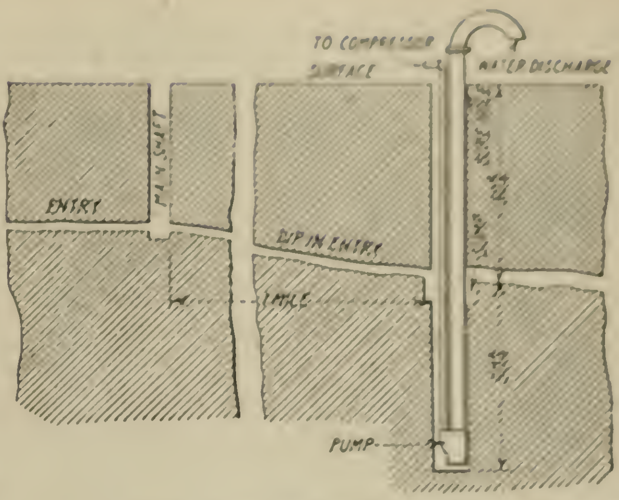

FIG. I. HOW MINE WORKINGS MAY BE DRAINED BY AIR LIFT.

Just such a case was that of the Clinton Coal Co., of Clinton, Ind. In this instance water had broken into the mine about 4,000 ft. from the shaft at a spot 160 ft. from the surface. It was not until after two lines of 3-in. pipe had been laid and proved inadequate that resort was had to the air lift. The lift was kept in operation 24 hr. a day for four months before the water was sufficiently reduced to resume mining, and it is of course still in operation a small part of the time.

When it is not feasible to carry the bore-hole below the level of the workings (which is necessary with the usual type of air lift in order to provide "submergence"), what is known as the Jones system of compressed air pumping may be employed. This comprises a direct acting pump operated by compressed air and working in conjunction with a normal air lift. The pump discharges both air and water into a closed tank, from which the exhaust air expels the water through an ordinary air-lift pump. The function of the direct-acting pump is to put a "head" on the water equivalent to that obtained by the submergence which would be necessary for a standard air-lift pump.

Notwithstanding the length of time during which the air-lift system has been in commercial use and the thousands of plants in successful operation, it is still considered more or less fashionable to make a mystery of its operation. This condition has been fostered to a great extent by the number of variable factors entering into the proposition, making it difficult to derive practical working formulas; also by the fact that manufacturers making a specialty of selling and installing these systems have obtained their data and experience at considerable expense and have consequently been unwilling to divulge to the

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*Condensed from *Coal Age*.

public the tables used when making calculations. The result is that less is known by engineers in general about the proper design and requirements for an air-lift pump than in almost any other branch of engineering practice.

Since the actual pumping level in a well or a mine is seldom known in advance of a test, it is customary to assume certain conditions of lift, quantity and submergence, as experience dictates, and design the air- and water-piping accordingly.

It is essential that both the air- and water-pipes be properly proportioned because the velocity of flow is a weighty factor, and it is here that experience plays a most important part. If too large a pipe is used the air finds its way through it without doing work. If too small a pipe is employed there will be excessive friction and inefficient expansion of the air bubbles.

LATEST DEVELOPMENTS IN AIR-LIFT PRACTICE.

Engineers specializing on air-lift work have learned much in the last few years. The proportioning of lift to submergence, thorough breaking up of the air, correct sizes of pipes, long sweeping bends and tees and umbrella discharge pieces to allow the water to flow along natural lines with the minimum of friction are all conducive to higher efficiency, better economy and a greater yield from a given source of supply. Along with these minor improvements have come two which are of real importance: One is known as the "booster," and the other, which is of particular interest to mine operators, is the "compound" air lift.

The booster, Fig. 2, is intended primarily for forcing the water, after it has left the regular air lift, through a horizontal or sloping length of pipe to its final destination. The air lift is economical only when lifting the water in a vertical direction, and if it is to be conveyed some distance horizontally from the source of supply it is necessary to either lift it high enough to allow it to flow to its final destination by gravity or to install some supplementary means, such as the booster, to convey it after it is discharged by the air-lift pump.

The booster simply consists of a closed tank into which the air lift discharges. The air and water separate in this tank, there being sufficient pressure on the air to force the water from the bottom of the tank to its destination. The air escapes constantly from the top of the tank through a restricted opening which maintains the necessary pressure to eject the water. The air discharged is usually piped back to the compressor. The device is extremely simple and forms practically a part of the air-lift pump.

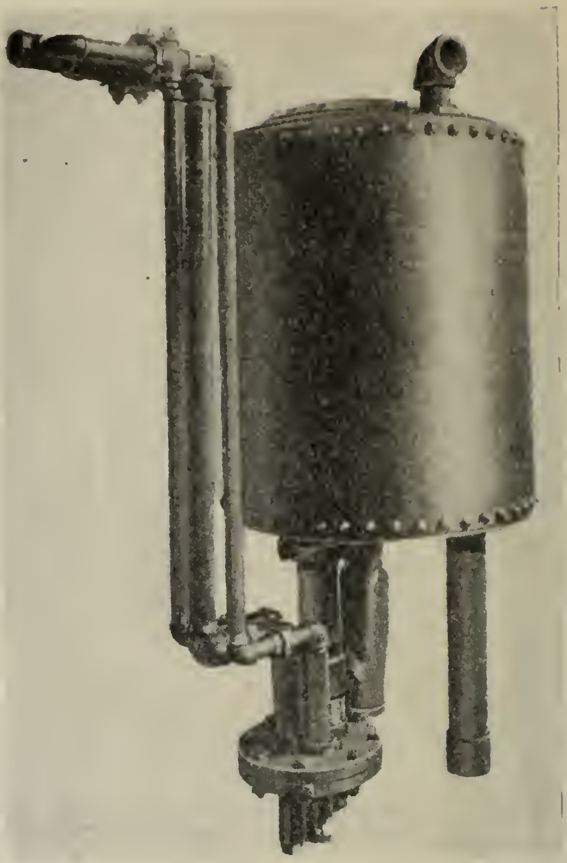

FIG. 2. THE BOOSTER TO DELIVER WATER HORIZONTALLY.

The compound air lift is a recent application of this system to mine drainage. Here a series of short lifts requiring low air pressure are installed in the shaft. Each lift is arranged to discharge into a tank from which the next lift takes its supply. The lifts are low, 11 ft. being considered the most advantageous, since it requires the very low air pressure of 5 lb., which pressure can readily be obtained from centrifugal compressors operated by exhaust steam turbines.

Since there is usually a vast quantity of exhaust steam going to waste around the average coal mine, this form of pump should prove both economical and efficient. Also, since the whole system is designed for only a 5-lb. pressure the piping, etc., can be correspondingly light and cheap; wood-stave pipes can readily be used. The exhaust air from the system should be of considerable aid to ventilation as it would maintain a strong current of air up through the shaft. In the event of a flood the compressor would simply have to be started up and the units above water level would commence discharging, those below coming into action as the water receded. This system has scarcely passed the experimental stage, but offers great possibilities.

In mines equipped with compressed air for other uses an air-lift pump can generally be used to advantage. In mines where no air is at hand the air lift has to stand its chance against other methods of pumping, and only a full knowledge of conditions and good engineering can decide between the two.

AIR DRIVEN DRILLS IN COAL MINES*

The makers of power-driven drills have been many years in fitting them for use in coal mines. The mechanical drill was first invented to work where speed, not cost, was the main consideration; namely, at the Mont Cenis tunnel between Switzerland and Italy. If the work on that tunnel had not been hurried, the interest and running costs would have been prohibitive, and something was wanted which would drill hard rock and drill it quickly. It mattered little if it was a heavy machine, for a number of holes had to be drilled at one time and on one line of entry.

DRILLING SHOTHOLES IN COAL OR SLATE.

But the coal problem is different. The coal can be drilled quite readily by hand, and only a few holes are necessary to shoot it down. So the main need is for an easily transportable drill not needing a truck to move it, which can be handled without a scaffold, a car or a drilling column, and capable of being operated in the narrowest of places or with the operator perched on a ladder. It must be available without any previous preparation for its use, except the connection with a pipe line such as is always in place when an ordinary coal puncher is in use.

And that kind of a drill has been long in appearing. Now that it has come it is quite likely to displace the old hand-drilling outfit, except perhaps where it is possible to sink holes with a breast auger. There is much trouble in drilling a hole in hard or sulphury coal, in slate or in clay. The preliminary sinking of a hole in floor and roof, the bringing up of a heavy extensible drilling post, placing it in position and then drilling, often in cramped quarters, takes much time and involves much labor. The work is by no means simple, even though it is done by hand.

With a 40-lb. Jackhamer drill there are no delays except to bring up the drill, connect it to the airline and hold it to the work. In even sulphury coal it will advance a foot in a minute, and so save time and the hardest kind of labor. The frequent trips to the blacksmith's shop, the broken drills, the uncertainties in coal production, the general discontent which prevail in a camp with hard coal, are all avoided. So little is known about the time expended on the various elements of coal mining that most operators are unable to tell what the items of drilling cost. Drilling certainly is no negligible item anywhere, and in some coals it is one of the most distressing.

T. B. Young states that when he was mine superintendent at Aladdin, Armstrong county, Penn., he found he could drill a 4-ft. hole with a Jackhamer quicker than he could set up a post drill to do the work. One man with a Jackhamer would do more than two men with a post drill.

Those who are using the Jackhamer find, moreover, that it can be used everywhere. It has been found valuable in the sinking of holes for trolley hangers, for which it is not too heavy. But if it is light enough for coal it is nevertheles heavy enough for drilling limestone. One man in lifting bottom in this material averaged 40 ft. per shift and drilled 1½-in. holes. This was at the mine of S. M. Hamilton & Co., at Wellscreek, Penn. Another man working for the Rockhill Iron & Coal Co. says he can bore a 6-ft. hole in solid limestone in 22 min. and can drill a hole of that depth without cleaning.

A PROSPECT HOLE IN ROCK 30 FT. DEEP.

In December of 1914, at the Staunton colliery of the Harleigh-Brookwood Coal Co., near Mahanoy Plane, a tunnel was driven by the Portland Contracting Co., and the contractors desired to know how near they were to some old works and if they contained watter. M. C. Reed, in describing the method of exploration, says:

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*Compiled by Editors of Coal Age.

"Having no prospecting drill we decided to drive the hole with a Jackhamer, using four pieces of steel, 3, 6, 9 and 12 ft. long, sharpened to a 2-in. gage. After drilling 12 ft. with this set of steels we welded a bit into a 2-ft. length of 1-in. pipe and a shank into another pipe. Then with extra heavy couplings we connected these to a 10-ft. length of the same size of pipe and drilled the additional 2 ft. without finding the old workings.

"Being so successful with this innovation we had the bit re-sharpened and added another 2-ft. section of pipe and proceeded to drill again. We continued in this manner, re-sharpening the bit and adding 2-ft. sections of pipe, until we found the old workings at a distance of 30 ft.

"The hole was drilled through a hard slate formation on about a 6 deg. pitch, and the Jackhamer rotated the steel perfectly until the hole was finished. It would be interesting to know how far we could have drilled, because the way the outfit was working when the hole was finished makes us feel we could have gone several feet further. However the size of the hole would soon have stopped us because of the size of the extra-heavy couplings. The diameter of our bit was about 1⅝ in. when the hole was finished."

Mr. Reed says he is drilling 12-ft. holes every day with the Jackhamer drill and is experiencing no difficulty in so doing. A prospecting drill costing about $750 would have done the work, it is true, but the flexibility of the Jackhamer is most convincingly proved by this work, for which, of course, it was never projected.

TUNNELS DRIVEN ONLY 30-IN. SQUARE SECTION.

To show the varied work to which the Jackhamer is adapted that done at Pax, W. Va., and cited by John Lindley, of the New River & Pocahontas Consolidated Coal Co., may be quoted:

"We have driven 11,460 ft. of narrow entry, including 7,868 ft. of 10-ft. entry, 3,292 ft. of 12-ft. entry and 300 ft. of 22-ft. entry. The slate in these roadways ran from 1 ft. to 18 ft. in thickness and averaged about 6 ft. Four overcasts were constructed, three of which have a cross-sectional area of 76 sq. ft. and the fourth of 104 sq. ft.

"Two waterway tunnels were driven, each 50 ft. long and 2½ ft. square. Such a small opening could not have been driven with any other drill and is quite unusual, but we desired to drive a tunnel of minimum dimensions. A ditch was constructed 125 ft. long, 18 in. wide and 3 ft. deep and another 50 ft. long and 18 in. deep, also with the help of the Jackhamer. The excavation in solid rock of a pump room 9x12x18 ft. has just been completed with the aid of the same handy tool.

"Our shaft is concrete-lined and very wet. We desired to make water rings in the solid concrete to drain the water to the sump by means of pipes. To do this we tapped our air line at the surface and swung a hose line down the shaft. We then took a Jackhamer drill, and working from the cage, drilled holes 4 in. deep in the sides of the walls, sloping downward and as near together as possible. Afterward we smoothed and pointed the work with hand drill and hammer so as to make a continuous ring trough around the shaft.

"In this manner we constructed three rings which carry the water to one end of the shaft from whence it is piped to a reservoir (also made by a Jackhamer) and pumped to another reservoir on the top of the hill. The water being pure it is used for the supply of the camp. Our best drilling with these Jackhamers was one 6-ft. hole in slate in 8 min. and six 6-ft. holes in coal in 24 min. The driller in making these results did not know he was being timed. He said he had drilled a slate hole 6 ft. deep in 5 min. when he was putting forth his best efforts. We are averaging 200 ft. of drilling per shift with two Jackhamers and four men. These men move from place to place and lay their own pipe lines.

"It is impossible to tell all the different positions and places in which we have used Jackhamer drills. We worked from small trestles of 2x4-in. lumber built up 6 to 15 ft. above the ground, supports which would have been wholly inadequate for the columns of other makes of drills. Since we started using the drills, the cost of upkeep has been comparatively small, not over $100 including a new set of bits, six extra 12-in. bits and one extra 36-in. bit."

ONE HAND-DRILLED HOLE COSTS AS MUCH AS 43 BY MACHINE.

At the Edgewater Mine, Ensley, Ala., the compressor recently broke down and the Jackhamer was put out of commission in consequence. Two men were put to drill a hole by hammer and steel. In three hours it was completed. The combined wages of the men was 50c. per hour, so the hole cost $1.50. As soon as the compressor was running the same amount of work was done in 7 min. with a wage charge of 30c. per hour. So the hole as made by the Jackhamer cost only 3½c. That same Jackhamer ran two years without a cent of repairs.

At a mine in central West Virginia a Jackhamer was used to drive through a "want" where the coal was replaced by white sandstone of an extremely flinty character. The heading measured 6x20 ft. The cost of driving the roadway without the drill was about $40 per yard; with it, it was driven for $22.

At the Black Joe mine in Kentucky, the trolley-wire hanger holes were put in by two men with a hammer and steel. In a whole day they put in 9 or 10 holes from 4 to 6 in. deep. One man with the Jackhamer can drill 9 or 10 holes in 10 or 15 min. At the same place a coal hole 5 ft. deep has been driven in 2 min.

R. G. Johnson, of the Dravo Contracting Co., states that largely by the help of three Jackhamers he sunk a 350-ft. shaft and lined it with concrete and put in a steel ladderway. His repair bill on the hammers was only $12.42. In establishing this record during the month of May the shaft was sunk 126 ft. and lined completely.

DRAINING A SWAMP BY AIR LIFT

At the American mine, Diorite, Mich., J. R. Thompson, manager and part owner, has devised a novel method for removing the water from a large swamp which lies above some of the mine's ore deposits. The swamp is about 2 miles in length and 1 mile in width, containing a great deal of water, and it was feared that if it ever came into the workings in large quantities it would cause trouble. To get rid of the water was considered quite a problem, but Mr. Thompson did some figuring and believed that he could solve it. He had a diamond-drill company put down several holes in the swamp, to find how close the ledge was to the surface, which would give some idea of the amount of water that the swamp held. The drills showed that the ledge varied from about 70 to 125 ft. below the surface. On the top there was about 10 ft. of black muck, with quicksand and gravel below. The diamond drill firm was asked to put down several 8-inch holes to the gravel, but its engineer stated that the task would be too great, as the quicksand would cause difficulties. Mr. Thompson then undertook the work himself, putting down the first pipe a distance of 76 ft. in three days after the tripod was rigged up. The pipe was not touched with a hammer. It was sunk by turning, and, with an auxiliary pipe, forcing air down the inside at the same time. When the pipe was bottomed in the gravel the air caused the water to shoot to the surface. This pipe is now producing about 1,000 gal. per min. Since that time five more pipes have been put down, some of them reaching a depth of over a 100 ft. One went through the gravel, being put down deeper than any of the others, and no water is now flowing from it. An attempt was made to blast it off higher up, but without success. One of the other pipes is also inactive. The four that are now working are sending about 5,000 gal. per min. to the surface. Two of the pipes are 10 in. in diameter, but they do not give any better results than the 8-in. pipes. This system of air-lift has lowered the water level in that huge swamp over 20 ft. during the short time that it has been in operation. When most of the water is out, a drift will be extended from the 140-ft. level of the mine and a 3,500-gal. centrifugal pump installed to care for any water that comes into the swamp later on. The method is very cheap, as the pipes need no attention after they get in operation. Some idea of the force of the water can be gained from the fact that granite rocks weighing as much as 8⅝ lb. were brought to the surface through one of the pipes. The water coming from below runs into a ditch that was made by using dynamite and forms quite a sizable stream.—*Eng. and Min. Journal.*

As a memorial to the late Dr. Joseph A. Holmes, director of the Bureau of Mines, of the Department of the Interior, the Colorado School of Mines has established the Joseph A. Holmes Professorship of Safety and Efficiency Engineering.

THEORY OF TWO-STAGE VACUUM PUMPING

BY R. S. HOWARD.

It has been the custom of some builders of dry-vacuum pumps to employ a two-stage unit with the seemingly peculiar feature of having the two cylinders the same size. At first thought there would appear to be no good reason for this, any more than for making a compound steam engine with the low-pressure cylinder the same size as the high-pressure. In the case of the steam engine it is difficult to see how any compounding could be accomplished with such an arrangement, and in the case of an air compressor (which is just what a dry-vacuum pump is) it would at first appear equally ineffective.

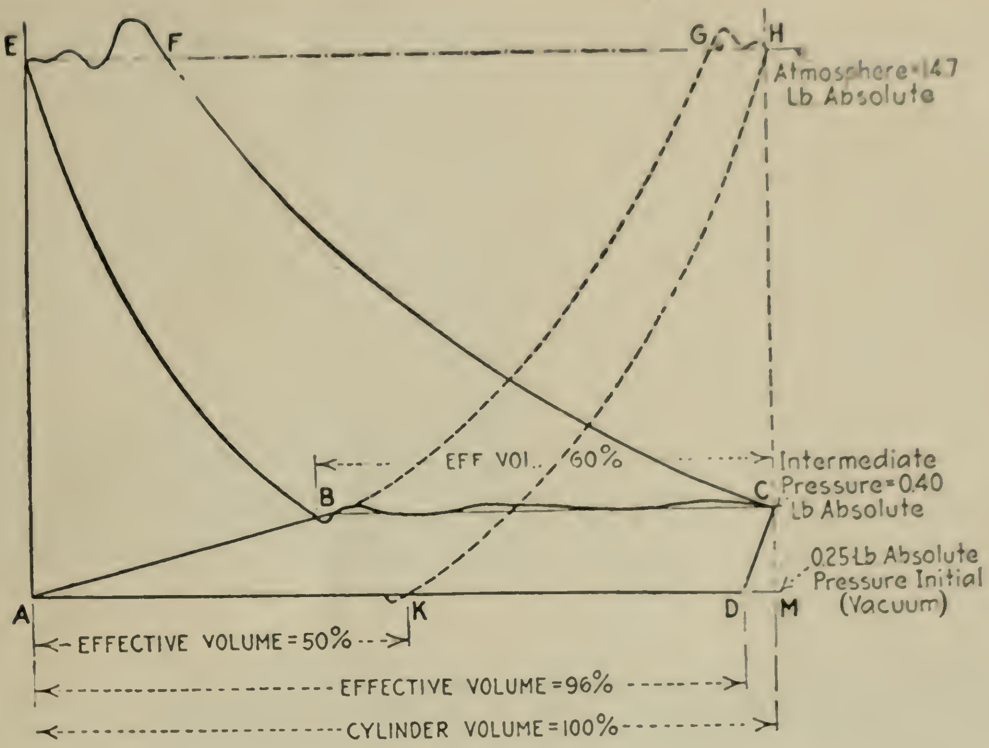
In the compound vacuum pump the effect of the cylinder clearance is so marked that this feature alone serves to create an actual effective cylinder ratio greater than unity, even with equal cylinder sizes, resulting in an actual compound compression (or exhaustion) the sole object of which is to increase the volumetric efficiency, or air output.

It is well appreciated that any cylinder must have a certain amount of clearance volume, or dead space through which the piston does not travel. This is made up of the necessary clearance between piston and cylinder head, which is made as small as is consistent with safety, and also the cavities and ports leading to inlet and discharge valves. The effect of this waste space is to trap some of the air as it is compressed, instead of allowing it to escape through the discharge valves. Then on the return, or suction, stroke of the piston this trapped air re-expands, helping to move the piston, it is true, but also helping to occupy space which should be taken up by incoming air. Whatever clearance air is thus allowed to expand keeps out just that much new air and so cuts down the intake and output of the pump. The greater the compression, the greater the amount of air that will be squeezed into this clearance space and the greater the amount of re-expansion on suction strokes to keep out the incoming air. Therefore, as the number of compressions increases, the less will be the relative amount of air delivered by the pump, and as the compressions increase rapidly with higher vacuum (26-in. vacuum is about 7¾ compressions, 28-in. vacuum is 15¾ compressions, while 29-in. vacuum is nearly 33 compressions), it follows that the volumetric efficiency of the cylinder decreases rapidly as the vacuum becomes higher.

Now, consider a compound vacuum pump that has a cylinder ratio of 2 to 1; that is, the low-pressure cylinder has twice the piston displacement volume of the high-pressure. It is evident that, clearance effects neglected, the low-pressure cylinder will deliver air to the high-pressure cylinder at some pressure intermediate betwen that of the vacuum from which it is pumping and the atmosphere or final-discharge pressure. As a matter of fact, with a cylinder ratio of 2 the intermediate pressure will be somewhere around 2¼ times the absolute vacuum pressure, depending upon the amount of radiation surface provided between cylinders. If there is an intercooler between and the air is cooled back to the initial intake temperature, the absolute intermediate pressure will be twice the absolute vacuum pressure (Ratio × initial pressure).

The effect of this intermediate pressure is to divide up the total number of compressions between the two cylinders, so that the low-pressure cylinder will be pumping through a much smaller range. Thus, assume a vacuum pressure of 1.5 lb. absolute, with a cylinder ratio of 2, giving an intermediate pressure of about $2\frac{1}{4} \times 1.5 = 3.38$ lb. absolute. Then the number of compressions in the low-pressure cylinder will be $\frac{3.38}{1.5} = 2.25$; whereas, with only single-stage pumping the compressions would have been $\frac{14.7}{1.5} = 9.8$. From the foregoing regarding the effect of clearance it follows that much less air will be trapped in the clearance space with only 2¼ compressions than with 9.8. Hence, the volumetric efficiency of the compound machine will be much higher than that of the single-stage.

If, instead of having a cylinder ratio of 2 to 1, we reduce it to 1.5 to 1, the intermediate pressure will be that much lower, the low-pressure compressions will be reduced, the clearance effect will be less and the machine will deliver more air. This process may be continued until finally the two cylinders become the same size, or the


E
F
G
H
Atmosphere=14.7 Lb Absolute
EFF VOL. 60%
B
C
Intermediate Pressure=0.40 Lb Absolute
0.25 Lb Absolute Pressure Initial (Vacuum)
A
K
D
M
EFFECTIVE VOLUME=50%
EFFECTIVE VOLUME=96%
CYLINDER VOLUME=100%

Cylinder Volume Ratio=1
Cylinder Effective Ratio=$\frac{96}{60}$=1.6=Low-pressure Ratio of Compression
Approximate Intermediate Pressure=1.6×0.25=0.40 Lb Absolute
High-pressure Ratio of Compression=$\frac{14.7}{0.4}$=36.7
Total Ratio of Compression=$\frac{14.7}{0.25}$=58.8

SINGLE-STAGE AND TWO-STAGE VACUUM PUMPING.

cylinder ratio becomes unity. Here it would seem the effect would become lost, because there would appear to be no intermediate pressure. This is where the clearance volume has a marked effect. It will be noted that if pumping from a given vacuum, say 1.5 lb. absolute, the total number of compressions will be $\frac{14.7}{1.5} = 9.8$, we accomplish 2¼ compressions in the low-pressure cylinder, the high-pressure cylinder must furnish the rest, or $\frac{9.8}{2.25} = 4.36$. Again, with the same vacuum, if we accomplish 1.5 of the compressions in the low-pressure cylinder we must have $\frac{9.8}{1.5} = 6.54$ compressions in the high-pressure cylinder. As the number of compressions in the low-pressure cylinder decreases, that in the high must increase to make up for it. The effect of decreasing the compressions in the low-pressure cylinder, we have seen, will increase its volumetric efficiency due to reduced clearance loss, so that the accompanying effect of increasing the number of compressions in the high-pressure cylinder will decrease its own volumetric efficiency due to its own clearance effect. The result of this is that the lower the cylinder ratio the more air the low-pressure cylinder will pump and the less air (cubic feet) the high-pressure cylinder will pump. This at once causes the low-pressure cylinder to build up an intermediate pressure higher than would result from the piston-displacement volume ratio only, so that even when the piston-displacement volumes of the two cylinders are identical there is an actual intermediate pressure and the machine is a true compound pump of greater output than a single-stage pump of the same size.

In the accompanying illustration will be found a set of diagrams which should help to make the conditions clear. First, consider a single-stage pump. Let the initial pressure of the vacuum be 0.25 lb. per sq.in. absolute, and discharging at atmosphere, of course. The indicator diagram would look something like the figure *ABGHK*. The amount of air handled per stroke would be represented by length *AK*, if *AM* represents the full stroke of the piston. The diagram shows the intake air (and the delivery) to be 50 per cent. of the piston displacement, the curve line *HK* (dotted) shows the reëxpansion of the air trapped in the clearance space.

Instead of a single cylinder, let the machine be provided with two (compound) cylinders in series, each of which has the same displacement, namely, lenth *AM*. After operation for a few strokes the respective volumes and pressures will have adjusted themselves to the conditions shown by the two indicator diagrams *ABCD* and *CFEB*, the former being the first-stage, or low-pressure, diagram and the latter the second-stage, or high-pressure. With this set of conditions it will be seen that the creation of an intermediate pressure *BC* of 0.40 lb. absolute produced a reëxpansion curve *CD*, in the low-pressure diagram, indicating an air intake of length *AD*, or 96 per cent. of *AM* the whole cylinder volume, instead of only *AK*, or 50 per cent. of cylinder volume shown before. The intermediate pressure is a direct result of the lesser volumetric efficiency of the high-pressure cylinder, which itself results from the greater number of compressions in that cylinder, reëxpanding from the clearance volume.

If there is no intercooling of the air discharged from the first cylinder before it enters the second cylinder, the length of low-pressure dicharge line *BC* must represent the volume taken into the high-pressure cylinder, shown to be 60 per cent. of the piston displacement of that cylinder. The line *EB* represents the curve of greater reëxpansion from the clearance of the high-pressure cylinder, due to the greater number of compressions or greater range of compression in that cylinder.

WILL IT PAY FOR THE ADDITIONAL COST?

Of course these relative volumes and pressures in any given machine would depend upon the construction, clearance, degree of cooling, etc., of that particular machine. These values have been chosen to show in a rather exaggerated manner just how the actual compounding is brought about with equal cylinder sizes in series and to show the resulting increase in volumetric efficiency thus obtained. The question as to whether the results are worth the extra expense of the double construction is a matter to be decided by the purchaser. Some of the modern high-speed vacuum pumps of single-stage construction are giving such good results relative to their initial cost that the respective merits of different makes should be carefully considered before purchasing any particular style.—*Power.*

TALC AND SOAPSTONE

The United States produces more talc and soapstone than all the rest of the world combined. Moreover, according to J. S. Diller, of the United States Geological Survey, our production has nearly doubled in the last decade, increasing from 91,185 short tons, valued at $940,731, in 1904 to 172,296 short tons, valued at $1,865,087, in 1914. Of talc alone the United States produced 151,088 tons, and of soapstone 21,208 tons.

Talc is a simple mineral of which soapstone is an impure massive form. Few people are aware how much we owe to talc and soapstone. It is one of the softest of minerals. It is so smooth and slippery that it has become a great panacea for friction in many branches of human industry.

There are nine States producing this useful mineral. New York continues to be the leading producer, yielding more than 57 per cent. of the total production of talc in the United States and far outranking all other States excepting Vermont, which has in recent years so greatly increased its production that in 1914 its output was about three-fourths that of New York. Of soapstone, Virginia holds the greatest supply, and backed up by Vermont it meets the great demand for washtubs, sinks, and fireless cookers.

Talc is used in making talcum toilet powder. the tailor uses it to chalk fabrics for new suits, and talc "slate pencils" and crayons have enabled many scholars to solve knotty problems. Talc bleaches our cotton cloth, and in paints we see it everywhere, but its chief use is as a filler in paper of many kinds, from roofing to newspaper.

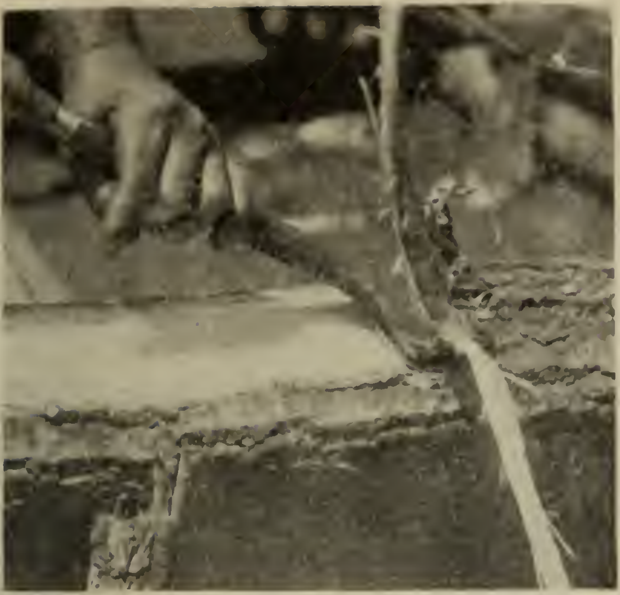


FIG. 1. PEELING THE TIE.

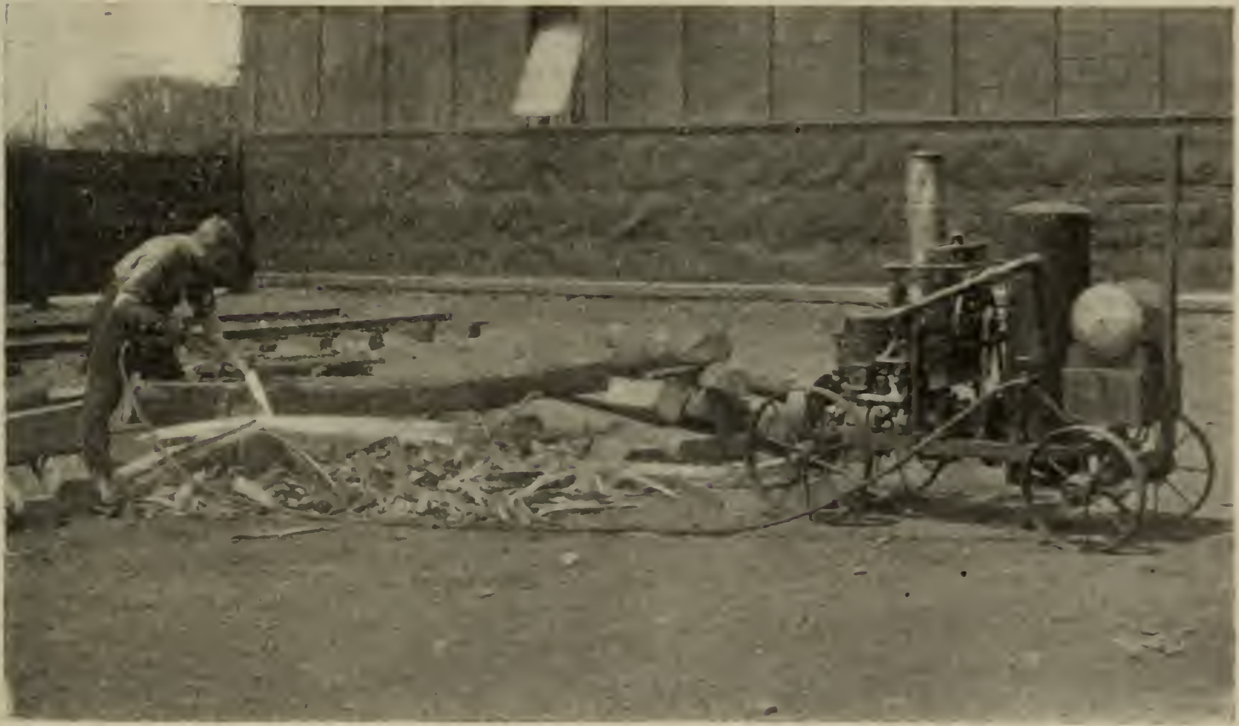


FIG. 2. COMPLETE TIE PEELING OUTFIT.

THE PNEUMATIC TIE PEELER

Railroad ties are flatted on two faces to a standard thickness, but to greatly prolong the life of the ties it is found necessary to peel the bark from the other sides. This has heretofore been a laborious and costly operation. The average peeler will do from 40 to 60 per day, receiving wages considerably above these of a common laborer. When piece work is the rule the prevailing price is 5 cents per tie.

This of course could not last in these days and there is now a pneumatic tie peeler with which any ordinary laborer, at laborers wages, will thoroughly peel 150 to 200 ties per day The device employed is an Imperial pneumatic hammer in conjunction with an imperial tie peeling tool The half-tones tell the rest of the story Fig. 1 shows the actual peeling of a strip of bark and Fig 2 is a view of a complete tie peeling outfit in a railroad yard. The light portable compressor outfit comprises an Imperial vertical single-acting compressor driven by a gasoline engine, with air receiver and all accessories costing approximately $300. The Imperial hammer used can also be used for chipping, calking and general repair work by the insertion of the appropriate tools in place of the peeler.

A CODE OF RULES FOR METAL MINES

A publication of considerable interest to the metal-mining districts of the United States has just been issued by the Bureau of Mines under the title, "Rules and Regulations for Metal Mines." It is to be known as Bulletin 75, and the authors are W. R. Ingalls, J. Parke Channing, James Douglas, James R Finlay, and John Hays Hammond. The Committee was originally appointed at a meeting of the American Mining Congress at Denver, Colorado, in November, 1906, and its object was the drafting of a modern law governing quarrying and metalliferous mining, which could be recommended to the several States for adoption.

This committee did considerable work and made a number of reports. In April, 1911, Dr. Joseph A. Holmes, Director of the Bureau of Mines, invited the committee to serve as a committee of that bureau with the idea of preparing a final draft of a law, and this was accepted.

The code of mining rules that has been finally drafted by the committee is the co-ordination of the experiences, opinions, and suggestions of a great many men who have assisted the committee in an advisory capacity and as directly employed aids. The former have included many engineers actively engaged in practice, members of professional societies, and members of the bar; the latter have included members of the regular staff of the Bureau of Mines and of the personal staffs of members of the committee. The committee has sought to obtain many points of view and to summarize many experiences. The draft that has been prepared is not offered as the last word upon this subject. There are many phases of this subject with which the committee has been unable to deal thoroughly. Thus the committee confesses its inability to formulate at the present time adequate rules covering the important subject of ventilation of mines. Similarly there are many practices in open-cut mining, by steam shovels, etc., regarding which the committee has felt unable to formulate rules. It is felt, however, that the rules so far as prescribed may advantageously be applied to open mining whether it be simple quarrying or the extraction of metalliferous mineral, as well as to underground mining.

In spite of the popular impression that the introduction of concrete, steel and brick is doing away with the use of wood, the State of New York is using more wood per capita than ever before. More than twice as much wood is used per person now than fifty years ago. More than six times as much wood per person in New York State than in Germany, and more than ten times as much as in Great Britain.

THE BAROMETER, OUR FEELINGS AND HEALTH

BY CHARLES E. BANKS.*

Every person capable of putting two and two together and obtaining the correct answer has been conscious of feeling out of sorts, as the printer would say, when the clouds hung low and the sun was obscured. A week of dull weather sets a whole community on edge; and the mental, moral and physical components of man are, at its close, about fit for the scrap heap. Under such atmospheric conditions, when prolonged for a number of days, an Englishman admits that he feels "seedy" and the American confesses that he is feeling "mean," both adjectives relating to a state of mental and bodily dumps.

This situation is generally attributed to the lack of sunshine, for every human being retains the ancient beliefs in the potentiality of the sun in its relation to his life and its well-being. A few sunless days or hours are not sufficient, however, to put a hoo-doo on the temperament and activities of a whole population; there is another important controlling agency, but little understood, even if appreciated, and it exercises a much greater influence than the sun in a given space of time. If the sunlight were absolutely necessary to our upkeep night-watchmen and laborers on the morning editions would be chronic invalids, and mine workers the most unhealthy people in existence.

The gaseous envelope of atmospheric air surrounding the earth is the medium in which we have to live, and it bears the same relation to the human family as the waters of the globe to the order of fishes. The air and water are essential to the life, as much a factor to man, as the quality of water to the fish. This normal atmospheric air exerts on our bodies a definite dynamic force, or physical pressure, of 14.7 pounds on every square inch of our bodies if we live at or near the sea level, and the higher up we go this atmospheric pressure diminishes until on the heights of the Rockies it is three or four pounds less. The normal pressure at sea level is indicated by the barometer as 30 inches, and it decreases by an established scale as it ascends these mountain heights. Most persons know that ascents of mountainous peaks, thousands of feet above sea level result in marked physical distress, difficult breathing, general depression at the summits, and in extreme cases bleeding at the nose and even from the lungs, due to this lessened atmospheric pressure. Just so it happens that when the barometer is "low" for a considerable period, say a drop from 30, the normal gage, to 29 or below, when stormy or dull weather ensues, we get the analogous effect imperceptibly, but in an appreciable degree; for it has happened that a definite measure of atmospheric pressure has been released from our bodies and naturally there follows a dislocation of our normal balance. The average adult man sustains on every pleasant day an atmospheric pressure of about fourteen tons at sea level, when the barometer reads at 30 and a drop of an inch or more, to 29 and below practically takes off half a ton or more of his load to which he is accustomed. Paradoxically, instead of feeling lighter and freer man feels a depressing effect on his tissues. He has to become adjusted to this alteration from normal tensity to one of unusual relaxation, and, while it is slow in its manifestations, as barometric changes are generally gradual, yet the effect in miniature is like going up to a great height on a mountain range. Of course this feeling is neither serious nor fatal, but the relaxed condition in unpleasant weather extending over a number of days makes us feel "out of sorts." While the spell is on we are in the doldrums, and the situation is recognized as of enough importance by careful surgeons to defer important operations, which can be postponed, when these unfavorable barometrical conditions prevail, and the patient needs every ounce of vitality to pull through.

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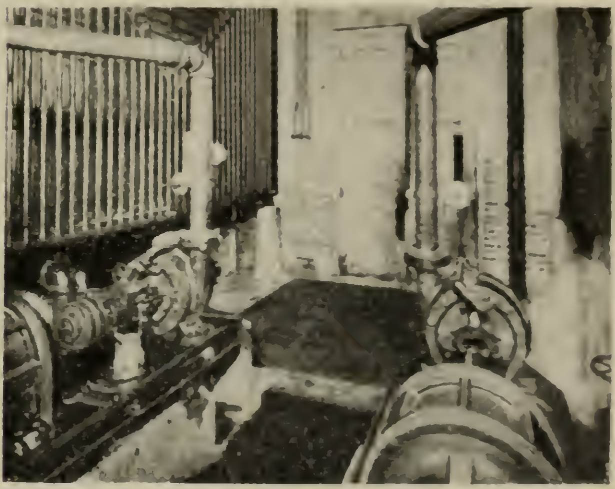
*Surgeon U. S. Public Health Service.

AN EFFICIENT AIR WASHER AND COOLER

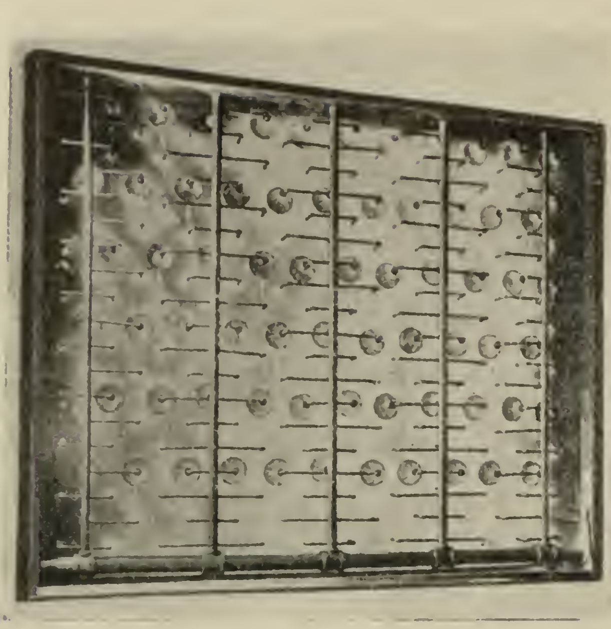
The Metropolitan Street Railway, Kansas City, Mo., has recently completed the installation of two air washers in connection with its largest turbo-generating plant at the corner of Second Street and Grand Avenue, and the company's engineering department now announces the successful outcome of its tests of the machines, which have a capacity of 80,000 cu. ft. per minute each. The installation includes complete equipments of motors, pumps patented spray nozzles, spray piping, screens, eliminator plates and other necessary appliances.

According to the railway officials, the expense of installing and operating the air washers has been more than justified by the results obtained—the removal of practically all the dust in the air entering the washer and the cooling of the air to the wet bulb temperature, thus increasing the capacities of the turbo-generators from 12 per cent to 15 per cent. The installation will undoubtedly prevent expensive burn-outs that are liable to result from carrying overloads, with an accumulation of dirt on the windings, and is believed by the railway electricians to constitute an effective insurance against the losses due to decreased efficiency and the delays required for repairs and cleaning the generator windings.



PUMP AND TEMPERING COILS.

The new machines, shown in the accompanying illustrations, were purchased by the Metropolitan Street Railway from the Spray Engineering Company, Boston, Mass., which followed its usual custom in erecting them for the purchaser. About 350 ft. of 1-in. galvanized steam piping were included in the equipment of each washer, to be used as tempering coils to reduce the humidity of the outgoing air, when required. These coils are constructed so as to operate satisfactorily under a steam-gage pressure of 5-lb. per square inch. The air-washer equipment furnished renders it unnecessary to have any extra equipment for washing down the eliminator plates, thus considerable expense is avoided. The eliminators consist of vertical plates, so arranged as to provide a large wet surface



SPRAYING EQUIPMENT.

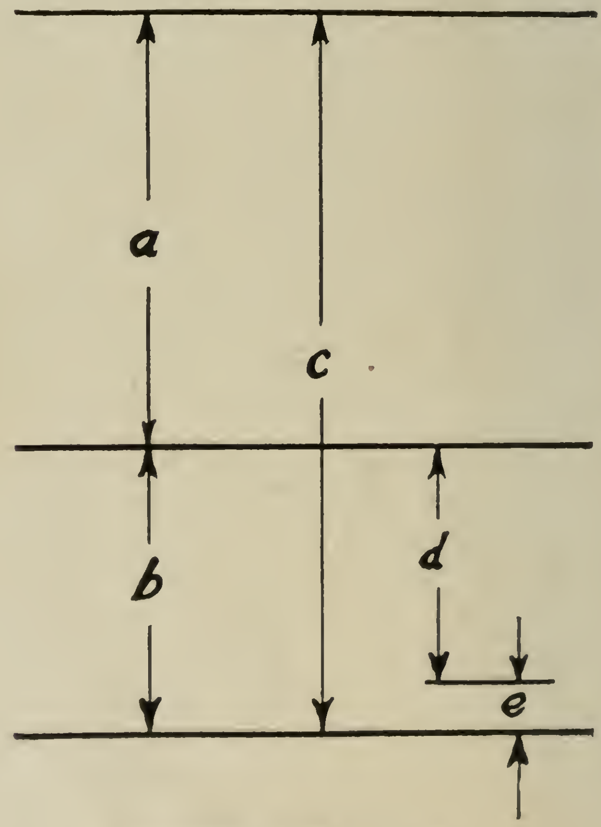
The washers are guaranteed to operate efficiently for ten years.

Each pump unit of the machines is mounted on a heavy cast-iron bedplate, so constructed as to extend under all parts. This arrangement prevents oil and water from dripping from the pumps and motors on to the floor, the bedplates being flanged and set at an incline so as to give perfect drainage. The motors are capable of operating without deterioration in a moist atmosphere from 40 deg. to 50 deg. Fahr., and the pumps operate readily with a 60 per cent. efficiency. All piping and fittings are of galvanized iron to prevent corrosion incident to a humid atmospheric condition.

The tests made in Kansas City have interested a great many electricians of the Southwest who came to witness them. The assistant electrical engineer reports that in the tests thus far made, the washer passes no free moisture that will show on a plate of clean glass held at a distance of 8 in. from the eliminator. The test for cleaning consisted in sifting 5 lb. of dry boiler soot into the mouth of the washer at a temperature of 70 deg. At the same time, a sheet of clean white paper was held at right angles to the air flow at about 6 in. from the flow openings. This test was conducted for ten minutes, after which not a trace of soot could be found on the paper. With a view to seeing what result would show in the case of the finest dirt, two wire screens were covered with a thin film of absorbent cotton, and one of these was inserted in the air duct to intercept the air as it entered the washer, while the other was placed in the duct leading from the washer. The first screen was allowed to remain in the air current continuously for six hours and the second for two weeks. At the end of the latter period it was found that the second screen showed no more soiling than the first, which had been exposed for the shorter period.—Electric Railway Journal.

PRESSURES AND VACUUMS

The little sketch by Professor E. W. Kerr, of Louisiana State University and here reproduced from the *Louisiana Planter*, shows the rather anomalous way in which vacua are indicated and recorded as compared with positive pressures. Steam pressures above otmosphere were formerly measured by the mercury column and stated in inches of mercury, but as higher pressures become common the mercury gage was abandoned and all pressures are now stated in pounds per square inch. Vacuum is still mostly measured in inches of mercury, although here too pounds would be more convenient. When we say there are 26 inches of vacuum we mean that the pressure is 26 inches *less* in



PRESSURES AND VACUUMS.

the vacuum chamber than the pressure exerted by the atmosphere, which continually varies within narrow limits for each locality, but at sea level averages approximately 30 inches of mercury or, say, 15 pounds to the square inch.

In the sketch the inner horizontal line represents the pressure of the atmosphere and the lower line represents the entire absence of pressure, or perfect vacuum. The upper horizontal line may represent any gage pressure, or pressure in excess of that of the atmosphere. Then of the several vertical lines, *a* is gage pressure, *b* is vacuum and *c* is absolute pressure. If *d* represents the actual vacuum in the condenser of a steam engine then *e* will be the difference between the condenser vacuum and perfect vacuum. With an atmospheric pressure of 30 inches of mercury, and a condenser vacuum of 26 inches, *d* would represent this 26 inches, and *e* would be 30-26 =4 inches.

In a working cylinder with the steam pressure against one side of the piston 20 pounds, gage, while on the other side there might be 26 inches of vacuum, the total force operative upon the piston would be determined by adding the vacuum to the pressure, but unfortunately the units are in quite different denominations.

It is to be noted, by the way, that the value of the mercury column is not precisely 2 inches to the pound as it is so convenient to assume. An inch of mercury represents .4915 pound, and this can be used as a multiplier. Then 26 x .4915 = 12.78 pound and the total driving force per square inch of piston as above assumed would be 20 + 12.78 = 32.78 pound.

It seems rather strange that manufacturers of vacuum gages, while still retaining the reading in inches of mercury, do not also give another circle of graduations reading pounds, but we do not know of any such gage on the market.

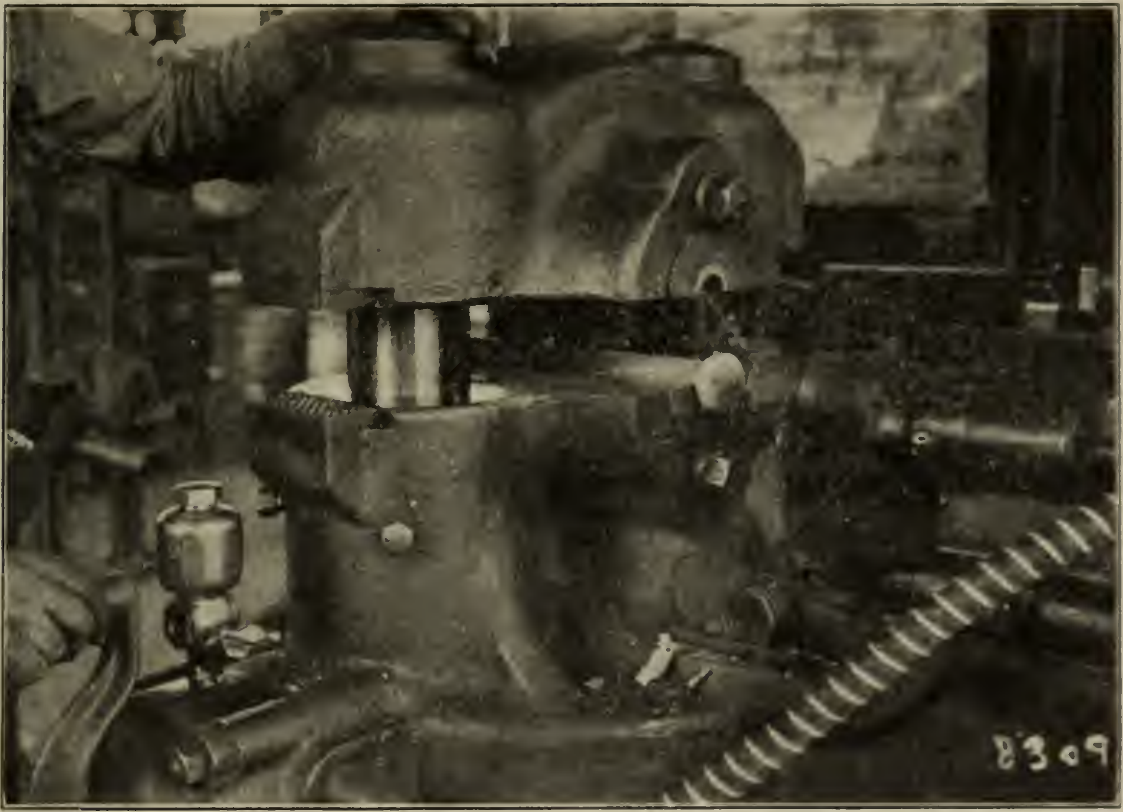


FIG. 1.

A LEYNER DRILL SHARPENER MAKING COUPLING PINS

A Leyner drill sharpener in the shops of a coal mining company was recently fitted with special dies for forging coupling pins for mine cars. This resulted in a considerable economy of the blacksmith's time.

For this purpose a piece of iron stock 1¼ in. in diameter and about 14 in. long is placed in the dies, projecting about 2 in. The flat-faced hammer or dolly upsets the head, as shown in Fig. 1, bringing down the length of the pin to

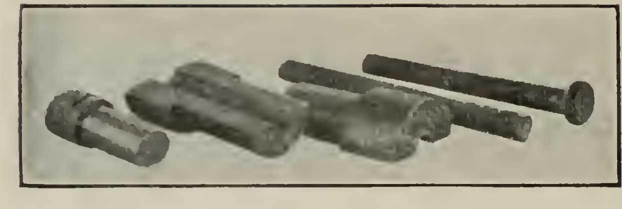


FIG. 2.

about 12½ in. The machine operates with compressed air and is controlled entirely by a single lever.

By equipping the sharpener with suitable dies and dolly the pins were turned out at the rate of about two per minute. This rate could have been even greater if it were not that there were only three forges in use and they could not supply the heated stock any faster.

Fig. 2 shows the special dies and dolly used for forging these pins, as well as a blank and a finished pin. It is planned to make other special dies and dollies so that the machine can be used for miscellaneous blacksmith work, such as welding car couplings. In addition to this special work, the sharpener is used for pointing various styles and sizes of drill steel used for cutting rock and coal in the mine.—*Coal Age.*

GAS ENGINES AT EXTREMES OF ALTITUDE

I venture I have the distinction of using two Foos engines at greater extremes of altitude, than any one else. One is at just 10,000 feet altitude and one at 198 feet below sea level.

For the past two years I have been running a Foos gas engine at my mine in Mono County, at the above elevation, as shown by the Government survey and checked by several aneroids. This engine is used for hoisting gold ore from a 200-foot shaft, and hoists a 700-pound bucket in one minute and seven seconds. It has never refused to do the work required of it, and has never delayed us ten minutes on account of engine trouble. This is a 7 h. p. engine and I first rigged it to a small hoist to do the prospecting work. I found it so very satisfactory that I have continued it as a permanent power.

Showing extremes, I will say that, on account of the excellent work my engine at the mine is doing, I purchased a small one to pump water at Calipatria, and it is working every day at a point 198 feet below sea level. I see no difference in the working of the two engines, except that I have to give the mine engine all the air I can, which I have done by taking out the air pipe entirely, and drilling the hole larger.—H. H. Clark in *The Gas Engine.*

UNEXPLODED DYNAMITE CHARGES SAFELY REMOVED BY AIR

By inserting the end of a hose, or short length of pipe, in a blast-hole that has failed to go off, turning on a light pressure of air through a valve from the drill line, and withdrawing the pipe with the pressure on, the unexploded dynamite may be removed with safety. The work should be done with care, and too much air pressure should not be turned on. This method was advocated by Jacob S. Langthorn, in a paper read at a recent meeting of the Brooklyn Engineers' Club, in preference to attempting to drill a new hole alongside the unexploded one. The latter practice is compulsory in New York City, under section 188 of the rules of the Municipal Explosives Commission.

The paper, which outlined the effective methods used in handling explosives on the Catskill Aqueduct tunnels, and the discussion which followed, dealt with tunnel practice, where the holes in the heading are all drilled at an angle. No one can be sure where the end of such a hole, 8 or 10 ft. from the face, is located, and when one of them has missed, it was asserted, it is dangerous to drill another hole anywhere near it. That the practice of attempting to drill a new hole in a tunnel heading where one or more holes of a round have missed is much more dangerous than withdrawing the unexploded charge with care, especially where compressed air is used, was unanimously asserted by several tunnel engineers of wide reputation, who took part in the discussion of the paper. John R. Healy, inspector of combustibles of the Bureau of Fire Prevention, stated that where compressed air was used as described the charge followed the pipe out of the hole as if it were a piece of iron and the pipe powerful magnet.

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EVERYTHING PNEUMATIC

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HOPE FOR MEXICO

In the last full week of August there came to hand, one after the other and not together, the issues of the Mexican Mining Journal for the successive months from March to August, inclusive. It seems quite clear that these have been held up somewhere on the way by the demoralization or paralysis of the mail and transportation systems of the unfortunate country. The fact that the papers have come to hand at last seems to show that things are improving and that normal conditions are being resumed.

We are pleased to note that there has been no demoralization of the editorial department, or in fact any department, of the publication referred to, and that the issues now before us are certainly as good as any we have ever received, or in fact better. The editorial in the August issue, which we here reproduce, it will be seen is overflowing with virile optimism. It is entitled:

MEXICO'S WONDERFUL VITALITY.

"Although conditions have been so unfavorable, during the past few years, at least in southern Mexico, that 'Mining! There ain't no such thing!' has been a favorite expression among mining men in the capital city, yet the mineral production of the country continues to be an important factor in the world markets. The recent drop of nearly three cents in the New York quotations for silver are said to be directly due to a huge shipment of accumulated bullion from Pachuca. Of course Pachuca is an exceptional camp even for Mexico, and the conditions which made it possible for the mines to continue operations there almost without interruptions were also exceptional. Nevertheless this isolated and exceptional circumstance gives one a sense of the importance of the country and its mines in the mineral industry of the world. If the mines of Mexico can still disturb the markets of the world after years of turmoil, stagnation and decadence, what can they not do when conditions favorable to enterprise and expansion once more return to the country? Another note found hidden among the rare cable despatches which we are still permitted to see, bears witness to the latent vitality of the country. It seems that in spite of five years of upheaval preceded by an equal period of apprehension, Mexican bonds are still quoted in foreign markets at a higher rate than those of certain countries in South America and Europe which enjoy a settled and apparently stable form of government. Evidently there is still plenty of confidence in the future of Mexico, and it is not likely that those of us who have waited courageously for the country to recover its political indigestion and for the return of prosperity will in the end be disappointed."

THE EXPLOSIVE AGE

In this cataclystic era "explosion" is a term oft used, and we are not at all surprised now to find our bright little New York contemporary, the Compressed Air Magazine, asking, "Why should not the present be called the age of explosives, or, perhaps still better, the explosive age?" War projectiles apart, our contemporary finds utilitarian science justify its claim, as it feels that in the exhibits at this season of county and state agricultural fairs nothing is more striking than the completeness with which the explosive engine, the gasoline motor, has superseded the steam engine. The Humphrey pump and the Diesel engine are, our contemporary admits, beginning to show the applicability of the explosive motor to the largest power units, in which direction, of course, compressed air helps. Hence is a case made out for thus dubbing the age, and the only alternative title we can suggest, having in mind the insensate folly of those who wrack and burn, is that which one applies to the inferno itself—combustion.—*Gas and Oil Power*, London.

THE LATEST COMPRESSED AIR MIRACLE

The following is taken from the New York Evening Sun, Aug. 31. It is certain that no other device than a "compressed air machine" could have done all that is alleged, and no one at all acquainted with "compressed air machines" could have given out such a batch of absurdities.

John Dillon, superintendent of the Degnon Construction Company, who is in charge of the work on the new subway at Fifty-ninth street and Sixth avenue, was arraigned before Magistrate Deuel in Yorkville Police Court to-day on complaint of Patrick Hanan, chief inspector in the Department of Water Supply, who charges him with violating an ordinance that forbids any one from making connection with a city water main without a written permit from the department.

Inspector Hanan charges that the company "tapped" a water main at Sixth avenue and Fifty-ninth street and has been using the water for five months.

It is further alleged by Hanan that the construction company used a compressed air machine in obtaining water from the main and that this machine blew poisonous gases into the water main which tainted the water.

He also alleged that the compressed air machine made the water meters in the vicinity of Fifty-ninth street and Sixth avenue register backward instead of forward.

The queer action of the water meters puzzled the Department of Water Supply for some time. Investigation led to the charge against Dillon.

Magistrate Deuel told Inspector Hanan that a police court had no jurisdiction in such a case. He advised Hanan to have the city bring suit in a civil court against the construction company.

FOURTH OF JULY DRILLING CONTEST

At Wallace, Idaho, drilling 15 minutes in hard granite, Kinsella and Leaf, from the Tamarack & Custer mine, won first money, $350, by putting the steel down $34^{11}/_{16}$ in.; Rossman and Haff, with 33⅞ in. to their credit, took second money; while St. Germain and Morrison, the Osburn drillers, were third with $33^{3}/_{16}$ in. Stokes brothers, of Moon Creek, drilled $32^{3}/_{16}$ in.

At Goldfield, Nevada, drilling in a block of granite from Rockland, California, Collins and Lindquist won first money, $500, by drilling 40¾ in.; Hughes and Jelik were second, $39^{7}/_{16}$ in.; Schram and Olson third, 38⅜ in. Single handed, Lindquist drilled 23⅞ in., winning $252; Brooks was second, with $19^{5}/_{16}$ in., and Malli was third, with $18^{9}/_{16}$ in. to his credit.

A HERO WITHOUT A GUN

King George has awarded the Edward Medal of the Second Class to James Wagenaar for bravery in saving life in the City Deep Gold Mine, Witwatersrand, South Africa on October 29, 1913. Wagenaar was working in the mine when he was informed by a native that five other natives down a winze, or steep incline, had been overcome by the fumes from explosives used in blasting (the debris brought down had interfered with the ventilation and prevented the dispersion of the gas). Wagenaar, tying a wet cloth round his mouth, immediately descended the winze to the place where the natives were lying in various stages of collapse, and, without assistance, brought out four of them in succession. He proceeded down the winze for the fifth time to bring out the last native, but was unable to carry him up more than a few yards, as he was fast being overcome by the fumes, and had himself to be helped out of the winze. Three men, who subsequently brought out the fifth native, also collapsed from the effects of the gas.

THE PROPHET BUSINESS

"What's this new dope they've got for knocking the mining game?" demanded the Pessimist.

"There isn't any new dope," returned Colonel Tepetate only half interested. "Even in Solomon's day, there was no use looking for anything new."

"I mean this stuff about ore and depth."

"That's all right. Did you ever hear of a mine that didn't peter out sooner or later?"

"Of course not. But what is the use of digging up that now, when things are gloomy enough already. Why call attention now to the fact that ore comes only in bunches, with the best and biggest end of the vein near the surface?"

"No use that I can see. Human nature, I suppose. When the gloom is particularly thick somebody is sure to think of something to make the shadows still a little deeper. When a man is having a birthday party nobody remarks that life is but a fleeting show and leads but to the grave. They pull that sob stuff on him when he is down on his back wondering whether it will be worth while to stay and meet the doctor's bill. But I can't find anything to weep about in that best ore near the surface business. Think what it would be the other way around. Suppose you had to sink 5,000 feet before it would pay to begin stoping. Besides, there are mines that pay at the depth of a mile. That is deep enough for me. Hoisting stuff a mile straight up is enough of a pull to satisfy anybody."

"But why did they do it?" insisted the Pessimist.

"You mean digging up that old skeleton when there isn't any feast on? I fail to see how that makes much differences. As I said before, human nature is like that. In hard times there is always some prophet snooping around telling the people that there is an end to all fun. In the old days they used to get sore and stone the prophets, and I've an idea that this particular prophet got his share of rocks too. I see that you're a bit sore yourself, and this Jeremiad wasn't aimed at you or me at all."

"It hits everybody in the mining business."

"Not at all! You and I and the most of us are not trying to sell stock on the old howl of 'richer ore lower down.' You and ninety-nine of the other fellows are not breaking your necks to dig down towards China. You are drifting sideways all you're worth because you're not extra fond of hoisting. As near as I make out this is about what happened:"

The old man took a look to see that his listener's attention was still with him. "As you know, there never was an ore deposit that made so much money for the stock jobbers as that on the Rand. Somebody got up a theory that the Rand mines were on an old gravel bed, one edge tipped up so that it comes to the surface. Some gravel beds are fairly uniform in values, and the Rand reef seemed to be that. The thing flattens out somewhat as it goes down, and what could be finer than a theory that a uniform bed of gold ore cut under a good stretch of southern Africa and stuck out into the ocean? Did you ever see a prettier layout for organizing companies and selling stock?"

"I see! but how many years would they have to dig before finding out what they had?"

"Under the circumstances nobody kicked on that, and it gave more time for selling stock. The idea that the district which is sending so many millions to London and is helping to make our few dollars look so small, could keep it up practically forever, tickled everybody over there, as you can easily see that it would. Quite the most beautiful and most welcome theory that was ever hatched."

"And this prophet fellow came along and took a crack at that lovely theory! Yes, I can easily believe that there might be several cheerful optimists willing to shy a pebble at him."

"It was rather cruel of him," ruminated the old man, always willing to look at the other side of a thing. "I can't think that he hurt it very much. It takes more than one prophet to sink a beautiful theory like that. England needs that gold, too. It's a heap easier to believe what you want to believe than something that you hope isn't so. Besides nobody has been down there, a mile or two underground, to see what the deposit looks like."

"So, he may be wrong, after all."

"In general he is right, of course. In particular, quien sabe. I am not in the prophet business."

"There's nothing in it."

"Nothing in what?"

"The prophet business."

"I never yet heard of one who tried to get anything out of it for himself."

"Then why do they do it?"

"They can't help it. A prophet is born that way. He just naturally has got to tell people that they are wrong, that they don't know what they are doing. It's his nature. He always picks out something that happens to be very popular at the time, and the result is that he never has many friends."

"He is a nuisance."

"I am not so sure of that. It is a good thing once in a while to show people how ridiculous they are, and to tip them out their hobbies. To be sure, the world never listens to its prophets. It heaves rock at them. But it may set a few to thinking. Anyway, the world has always had them and, I suppose, always will. The modern prophet has a rather tough time of it. He can't fall back on a miracle, like Daniel and Isaiah used to do."—*Mexican Mining Journal.*

TESTING A REFRIGERATING PLANT WITH AIR

BY A. G. SOLOMON.

Using an ammonia compressor for pumping an air test on a plant is something that should be given considerable attention. It is customary to test the high-pressure side of a plant with 300-lb. air pressure and the evaporating coils and other low-pressure piping with from 100 to 150 lb. Many engineers seem to belittle the danger of using the ammonia machine as an air compressor.

TESTING NEWLY INSTALLED SYSTEM.

First, consider the risks in testing a new plant free from oil and ammonia. The machine is new and has been turned over by hand to ascertain that the clearance is right. Then it is turned over with steam, or with the motor if it happens to be motor-driven. With the steam drive the speed can be as slow as desired, but with the motor drive full speed is quickly reached. During this time the compressor does not draw anything from the evaporating side, as an opening is left so that the air is simply pulled in and forced out. Usually, much oil is put into the compressor to lubricate the valves and piston. Some of this lodges in small pockets in the valve cages and the globe valves in the pipes. After everything is ready the machine is turned into an air compressor and the test is begun. A full stream of water is turned through the water jackets, and often a hose is fastened to the discharge line and water allowed to flow over it to remove some of the heat of compression.

The machine should be stopped and allowed to cool after a discharge temperature of not over 250 deg. F. is reached. A thermometer should be inserted in the discharge line at this time, even if it is not left there for future use. The writer believes it would be a good thing to insist on discharge-temperature readings being taken during the test. The erecting engineer should be instructed as to what is a safe temperature and should keep within that limit. The oil for lubrication of the new compressor should be furnished by the builders, to avoid the danger of using an inferior lubricant or one with a too low flash temperature. This will mean that the thermometers and the oil will be a part of the erecting engineer's equipment. The lubricant used in many refrigerating plants is good as far as the low-temperature test goes, but when it comes to the question of gasifying under high pressure and temperature, that is another story. The danger of gas ignition and the resultant internal explosion is not any greater in the old system than in the new. The result of such explosion may be more serious in the former, owing to the possibility of ammonia being liberated.

SCALE MAY START EXPLOSION.

In one way, the writer thinks, a new system is more liable to explosion than an old one. The cylinder surface and the moving valves and piston are not worn to a smooth finish, and the friction is therefore greater.

Minute irregularities in these surfaces may easily create friction which may cause a spark that will ignite the gas given up by the oil used for lubrication. In the old compressor this danger is not present.

Another producer of sparks may be the particles of scale in the pipes. However well the piping is cleaned, there is some scale which becomes loosened and may find its way into the cylinder. A small piece of hard scale, getting between the piston and cylinder wall, may cause a spark. Also small particles of scale and grit are sent through the compressor valves and the pipe work at high speed. These may cause sparks.

SOAPY WATER AS LUBRICANT PREVENTS EXPLOSIONS.

There is one positive preventive for such explosions in testing a new plant. Do not use oil for lubrication. Use soap and water or some other material which will not give up a gas when subjected to heat. The amount of moisture thus introduced into the system will do no harm, as nearly all of it will be caught by the oil separator in the discharge line.

The proper way, and a way the writer believes should be insisted on, is the use of a special air pump for testing both new and old systems. Such an apparatus can be made to deliver air at a low temperature, and thus do away with the danger of explosion.

Where it is necessary to use a motor-driven ammonia compressor for pumping the air test, it should be stopped often and allowed to cool. This is annoying and takes a little more time, but it is safe. An hour or two more or less will not make any difference to the plant, whereas the bursting of a cylinder, receiver, valve or pipe work may delay the starting of the plant a week or more.

FUMIGATION ABANDONED IN NEW YORK

After a year of testing the efficacy of fumigation in cases of contagious diseases the board of health has announced that the practice of fumigation in infectious diseases in Brooklyn will be immediately discontinued. That means that fumigation has given place to more advanced methods in all the boroughs. In December, 1914, the practice was discontinued in Mannhattan, the Bronx Queens and Richmond, but to satisfy critics and for the purposes of comparison it was continued in Brooklyn. Now Dr. Goldwater has ordered fumigation discontinued altogether. During the period when the health authorities were debating the efficacy of fumigation many experiments were made. The health department calls attention to other and more efficient methods of preventing the spread of disease, that is, cleaning, fresh air, and sunlight, and particularly the renovation of premises by repainting and repapering. Dr. Goldwater said that statistics gathered by the department show that the discontinuance of fumigation is justified. These show that there has been no increase in the prevalence of the various diseases and that better and more efficient disinfection has been performed

DIRECTOR OF THE BUREAU OF MINES

President Woodrow Wilson on Aug. 27 named Mr. Vanney H. Manning, acting director of the U. S. Bureau of Mines, as director of the Bureau, vice Dr. J. A. Holmes, deceased. Director Manning is from Holly Springs, Miss., and has been connected with the bureau ever since its establishment. He had been assistant director, and, when Dr. Holmes was compelled to relinquish his duties because of his health, Mr. Manning was made acting director.

NOTES

Ordinary blasting powder is not affected by the cold, but in warm damp weather it is liable to take up moisture and thus lose strength. It is made up largely of nitrate of soda with 10 to 15 per cent sulphur and charcoal, and contains no liquid ingredient. Ordinary handling and shaking in transportation does not affect it. It is the nitrate of soda that attracts the moisture in the air.

Acetylene gas is not poisonous, but, like nitrogen, will not support life. One great advantage of acetylene is that it does not make smoke or soot. The spectrum of acetylene discloses the fact that it is the closest approach to sunlight of any of the illuminants. Up to the present no safety-lamp, using acetylene as a source of illumination, has been devised for gaseous mines, but in non-gaseous coal mines it is safe to say that 70 per cent of the miners are now carrying acetylene lights.

In sinking a shaft in the Lake Superior district it is asserted that the speed of sinking was increased by 55 per cent by the use of a blasting box. Instead of using a long fuse for each hole, one long fuse was used to ignite the powder in the box and this in turn ignited all the short fuses connecting the holes with the box. This is a good idea of course, but that the speed of shaft sinking could be increased 55 per cent by it is an absurd exaggeration.

A substitute for Pumice Stone has been produced answering all the purposes of the natural stone, which consists of a sort of glass rendered porous by expansion. Its constituents are sandstone and clay, and there are said to be no fewer than 10 different grades of the stone manufactured. There is a hard and a soft kind designed for the leather, felt and wood industries; another kind for stucco workers and sculptors; a soft, finely grained variety for polishing woods and for tin goods; another kind suitable for the treatment of lithographic stones; while other varieties are fitted for various duties.

Gas meters in New York are to be photographed by meter-readers in the future, and the gas company believes by adopting this method it will insure an accuracy which it is hardly possible for the hand, eyes and mind to attain in keeping such records. A device has been invented for photographing the indicators of the gas meters. The readers will be equipped with a small camera and a spool of film, the entire outfit being not unlike the ordinary camera. The camera fits over the indicator in the gas meter and by pressing a button a flood of electric light is thrown on the dials and the exposure is made.

The United States leads the world as an exporter for the first time in its history. Total exports for the fiscal year, ended June 30, 1915, aggregated $2,768,600,000, as against $2,170,100,000 for the United Kingdom. This is an increase of 17 per cent. for the United States and 30 per cent. for the United Kingdom compared with last year. Our exports 20 years ago, in 1895, were $807,500,000, against $1,391,000,000 for the United Kingdom. Exports of manufacturers from this country in 1821 were only $8,000,000, but in 1915 they were $1,166,000,000.

A course of instruction and training in sales engineering has been organized by the Ingersoll-Rand Company, 11 Broadway, New York. Qualified and approved graduates of engineering schools, in classes of fifteen or twenty, are distributed and passed along through the factories of the company, when they become familiar with the processes of manufacture, the details of design, construction and operation of the various apparatus manufactured, the assembling, testing, record keeping, etc., and during the course attending also lectures and specific instruction given by the engineers, experts and sales managers of the company.

The steamship "Pennsylvanian," of the American-Hawaiian line, recently set a new record for time of transit from Philadelphia to San Francisco via the Panama canal, making the voyage in 14 days 17 hrs. 25 min. The distance is 5,130 nautical miles, making an average speed of about 348 miles a day. The Canal Record points out that if this vessel had made the voyage by way of the strait of Magellan, a distance of 13,003 miles, at the same speed, the voyage would have required approximately 37 days and 8 hours, or two and one-half times as long as the trip by way of the canal, and that the use of the canal saved about 5,965 bbl. of fuel oil, which would cost $4,772.

Great difficulty has been experienced in the past in landing supplies and mail at the Scotch Cap and Cape Sarichef light stations, Alaska. Owing to the situation of the stations, the condition of the sea is very often unfavorable to making landings through the surf for days at a time. Measures have therefore been taken recently by the Bureau of Lighthouses for the purchase of line-throwing guns for these stations, and for the Cape St. Elias light station, Alaska, now in course of construction. It is believed that these guns will be very useful in landing mail and in connection with landing supplies and transferring the keepers to and from the stations during unfavorable weather.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 3.

1,148,574. PROCESS OF ISOBAROMETRICALLY FILLING VESSELS AND APPARATUS THEREFOR. ADOLF CASPARE, Rotterdam, Netherlands.

1,148,601-2-3. VACUUM - PRODUCING DEVICE. JAMES MCALEAR, Chicago, Ill.

1,148,706. MILKING-MACHINE. CHARLES SLYVESTER MOORE, Danvers, Mass.

1,148,713. ASSEMBLING - RIG. WILLIAM H. PARRY, Kenosha, Wis.

1,148,738. REGULATOR FOR MIXED-PRESSURE ENGINES. OTTO BANNER, Easton, Pa.

1,149,152. ECONOMY AIR-BRAKE APPARATUS. WILLIAM G. CANION, El Paso, Tex.

1,149,169. VACUUM-CLEANER FOR RUGS. ALONZO D. SEAMAN, Milwaukee, Wis.

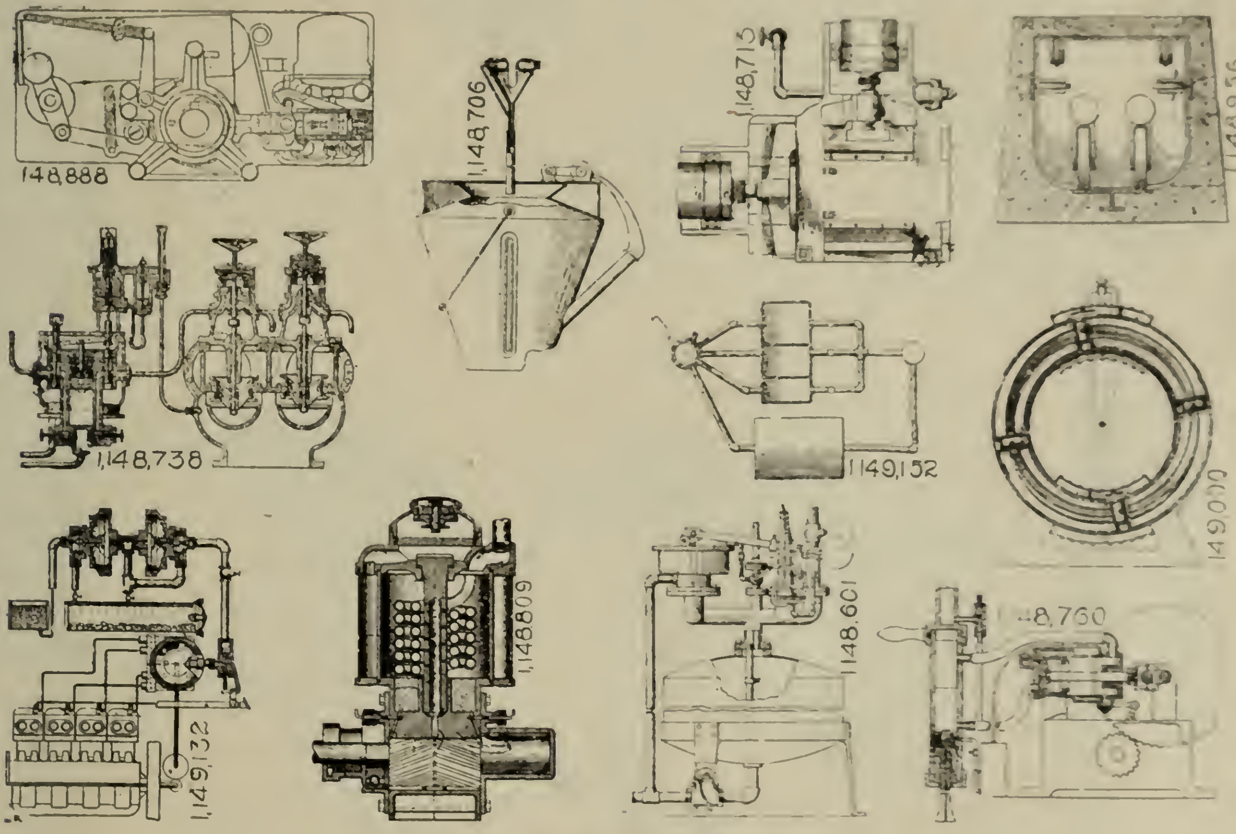
AUGUST 10.

1,149,227. PNEUMATIC SWEEPING DEVICE. EDWARD P. STRODE, Newark, N. J.

1,149,253. CLEANING COTTON DEVICE. EUSTICE E. DICKERSON, Cleburne, Tex.

1. In an apparatus of the character described, in combination with a blower, an air pipe leading therefrom and a boll breaker connected by said pipe with said blower, of means located at the inlet to the boll breaker for increasing the pressure of the air entering said breaker from said pipe, said means being perforated to permit the escape of extraneous matter from the cotton and air prior to their entrance to the boll breaker.

1,149,254. APPARATUS FOR PRODUCING OZONE AND SEPARATING GASES. HORACE DUMARS, Glen Ridge, N. J.



PNEUMATIC PATENTS AUGUST 3.

1,148,760. ROCK-DRILL. CLARENCE A. DAWLEY, Plainfield, N. J.

1,148,809. AIR-COMPRESSOR. MORRIS C. WHITE, Los Angeles, Cal.

1,148,888. PNEUMATIC MOTOR-STARTING APPARATUS. HARRY A. BROOKS, Glendale, Cal.

1,148,956. PNEUMATIC-DESPATCH TUBE AND CARRIER. RODERICK G. COLLINS, JR., New York, N. Y.

1,149,000. ELASTIC-FLUID GENERATOR AND MOTOR MECHANISM. SHERIDAN D. SIMMONS, New York, N. Y.

1,149,132-36. STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. HARRY W. HAMILTON, Indianapolis, Ind.

1. In combination, an internal combustion engine, a gas generator which produces gas under pressure sufficient to start the engine and in which the production of gas is controlled by the pressure of such produced gas, and a control valve for admitting gas from said generator to said engine.

1,149,259. VALVE MECHANISM. HIRAM A. HATFIELD, Nogales, Ariz.

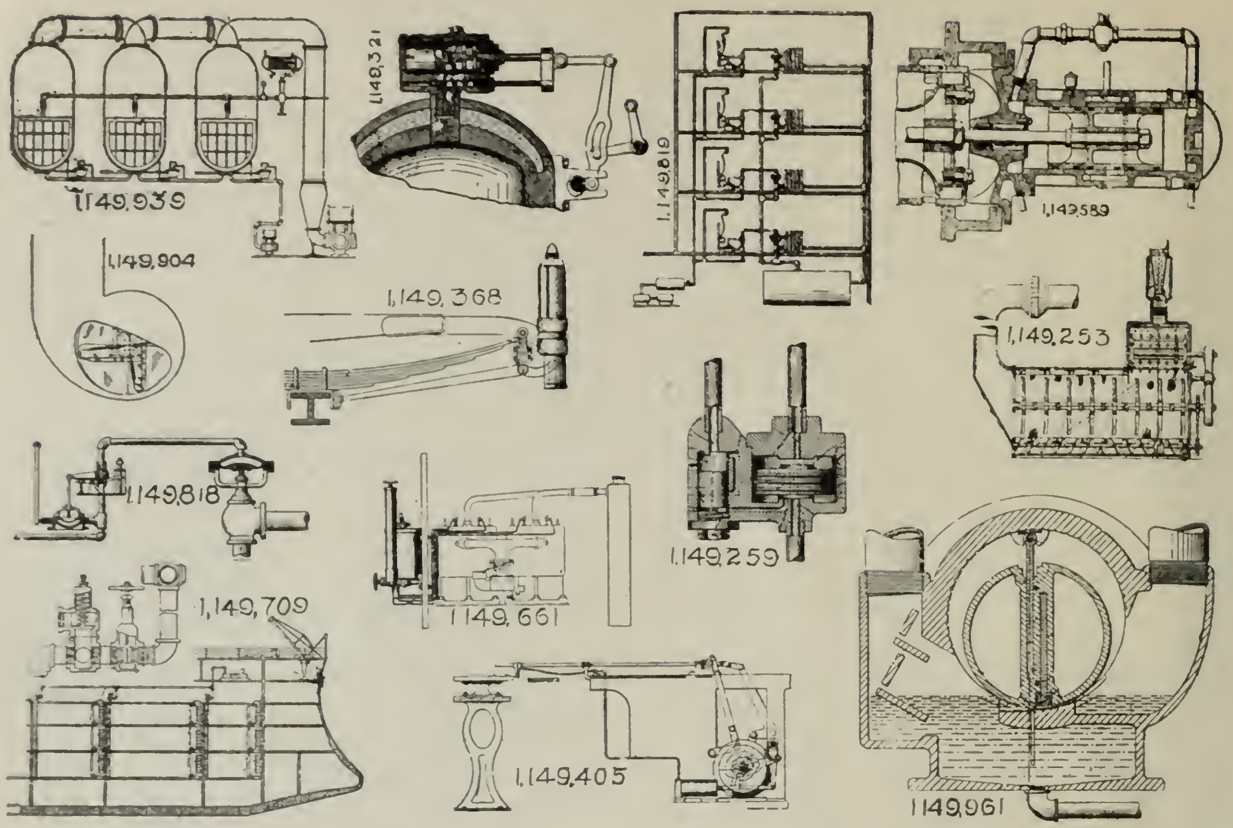
1,149,321-2-3. METHOD OF AND APPARATUS FOR DELIVERING LIQUID FUEL TO OIL-ENGINES. CHARLES WHITING BAKER, Montclair, N. J.

1. The method of operating liquid fuel engines consisting in measuring in separate closed chambers the quantity of liquid fuel required for one working stroke of the engine at full load and the quantity of compressed air required for atomizing it, and drawing from said chambers such a part of their contents as the load on the engine requires.

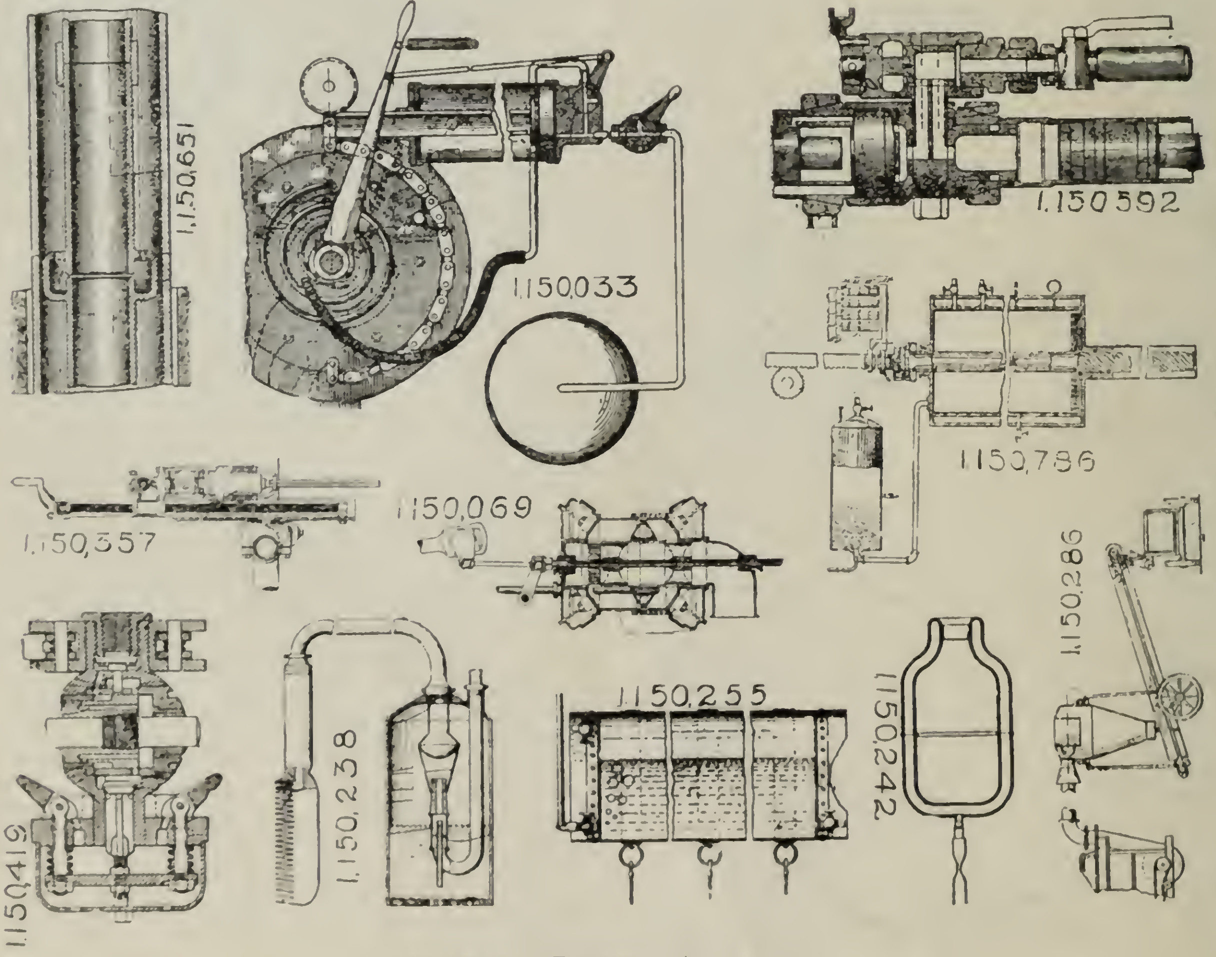
1,149,324. COMPOUND AIR-PUMP. GEORGE W. BALDWIN and PHILIP H. STAPLEY, Bridgeport, Conn.

1,149,363. VEHICLE AIR-SPRING. JONATHAN S. GREEN, Pittsburgh, Pa.

1,149,405. PNEUMATIC DEVICE FOR FEEDING FINISHING-BLANKS TO BOX-COVERING MACHINES. MELVILLE E. PETERS, Denver, Colo.



Pneumatic Patents August 10.



Pneumatic Patents August 17

1,149,589. AIR-CUSHIONING MECHANISM. LUTHER D. LOVEKIN, Philadelphia, Pa.

1. In a steam engine, the combination of a reciprocating valve, a cushioning piston attached thereto, a cylinder in which said piston works, a source of pressure fluid, and means for intermittently connecting the two ends of the cylinder to said source as said piston moves through its mid-stroke position.

1,149,638. CENTRIFUGAL FAN AND PUMP. SAMUEL CLELAND DAVIDSON, Belfast, Ireland.

1,149,661. STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. THOMAS J. MCCARTHY, New York, N. Y.

1. A vapor starting apparatus for internal combustion engines, comprising a liquid fuel tank, means for placing a body of liquid fuel and a body of air within said tank under pressure, a mixing chamber connected by separate channels with said air and said liquid in the tank, controlling means for causing a jet of air and a jet of liquid flowing through said channels to impact with each other in said chamber, and means for delivering the resulting explosive gaseous mixture directly into the engine cylinders.

1,149,709. AIR-PRESSURE SYSTEM AND METHOD OF OPERATION. WILLIAM WALLACE WOTHERSPOON, New York, N. Y.

1. The method of applying air pressures to ships' compartments to expel water from a leaking compartment and to reinforce said compartment against strains due to internal pressure, which method consists in applying different degrees of air pressure internally to the leaking compartment and surrounding compartments respectively, said pressures being predeterminately selected so that the leaking compartment will receive sufficient pressure to expel water therefrom, and the other compartments will receive a relatively lower pressure to reinforce the walls of the leaking compartment against the strains due to the higher pressure therein.

1,149,818-9. APPARATUS FOR REGULATING TEMPERATURE. JAMES F. GALLAGHER, New York, N. Y.

1,149,904. BLOWER-FAN. JAMES E. FOSTER, Clarksburg, Ontario, Canada.

1,149,939. VACUUM EVAPORATING APPARATUS. EZRA A. NEWHALL, Philadelphia, Pa.

1,149,961. ROTARY VACUUM-MACHINE. WILLIAM E. SHORE, Toronto, Ontario, Canada.

1,149,969-70. BRAKE MECHANISM. SYDNEY E. TAFT, Holliston, Mass.

AUGUST 17.

1,150,034. STARTING DEVICE FOR ENGINES. JOHN O. HOBBS, Chicago, Ill.

2. In a starting device for explosive engines, the combination with a shaft, of a crank loosely mounted upon said shaft, means for applying fluid pressure to said crank, a fluid pressure operated clutch for locking said crank to said shaft, means for simultaneously controlling the application of fluid pressure to said crank and clutch and for releasing the fluid pressure from said crank, and automatic means for releasing the fluid pressure from said clutch.

1,150,069. BLOWING-ENGINE AND THE LIKE. CLARENCE N. SCOTT, Buffalo, N. Y.

1,150,238. AERATING DEVICE. DAVE WIMBRAY, Hot Springs, Ark.

1,150,242. METHOD OF PRODUCING A VACUUM IN A METALLIC-WALLED CHAMBER AND SEALING THE SAME. FREDERICK W. BARTLETT, Caldwell, N. J.

1,150,255. VESSEL - RAISING APPLIANCE. HENRY ARTHUR DICKS, Mandeville, La.

1,150,286. CONVEYING AND SEPARATING APPARATUS. FRANK A. MIDDLESTATE, Edison, Wash.

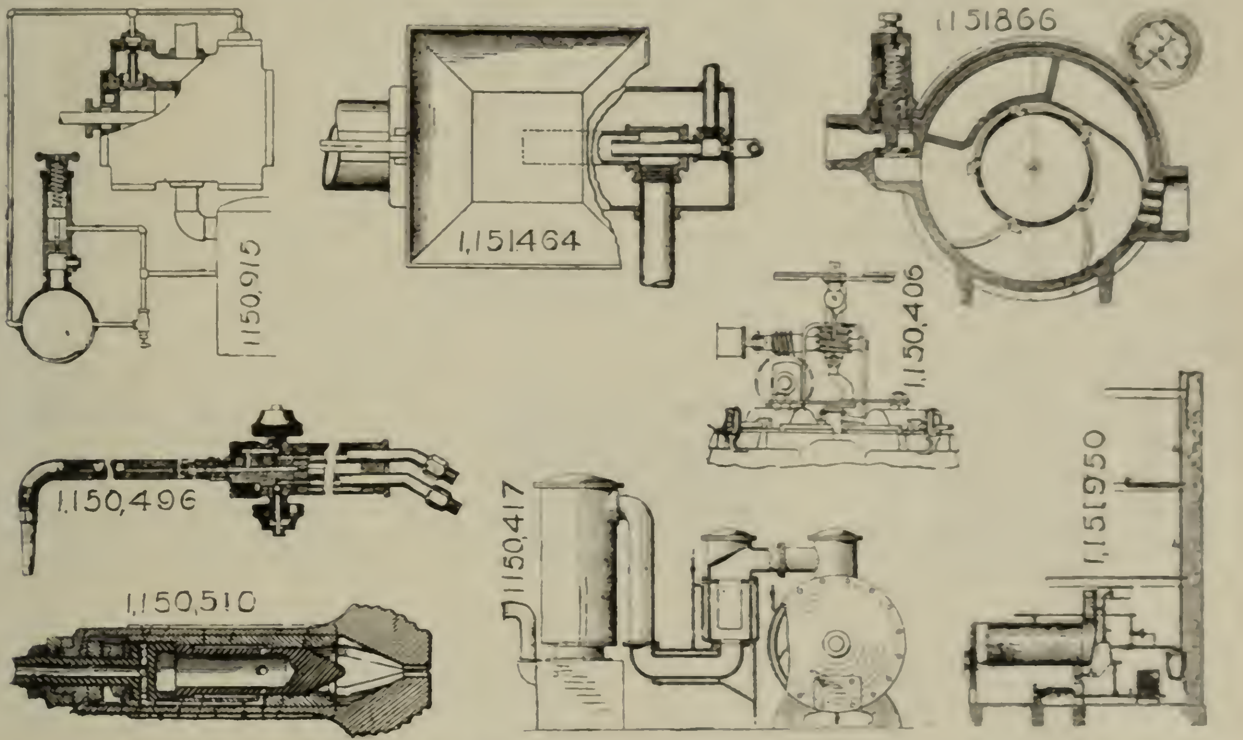
A device of the class described, comprising in combination with a relatively fixed conveying pipe, a frame movable relative thereto, a pneumatic separator provided with an inlet tube and with outlet tubes for the air and separated material, and means for rotatably supporting the said separator on said frame whereby connection may be readily established between said conveying pipe and the inlet tube of said separator.

1,150,357. PNEUMATIC DRILL. GEORGE H. GILMAN, Claremont, N. H.

1,150,419. FLUID-OPERABLE FLUE-CLEANER. PHILIP J. DARLINGTON, Hartford, Conn.

1,150,531. PNEUMATIC DOOR FOR REFRIGERATOR-CARS. SIGFRID A. MILLER, Oakland, Cal.

1,150,592. PRESSURE-FED TOOL. GEORGE H. GILMAN, Claremont, N. H.



PNEUMATIC PATENTS AUGUST 24.

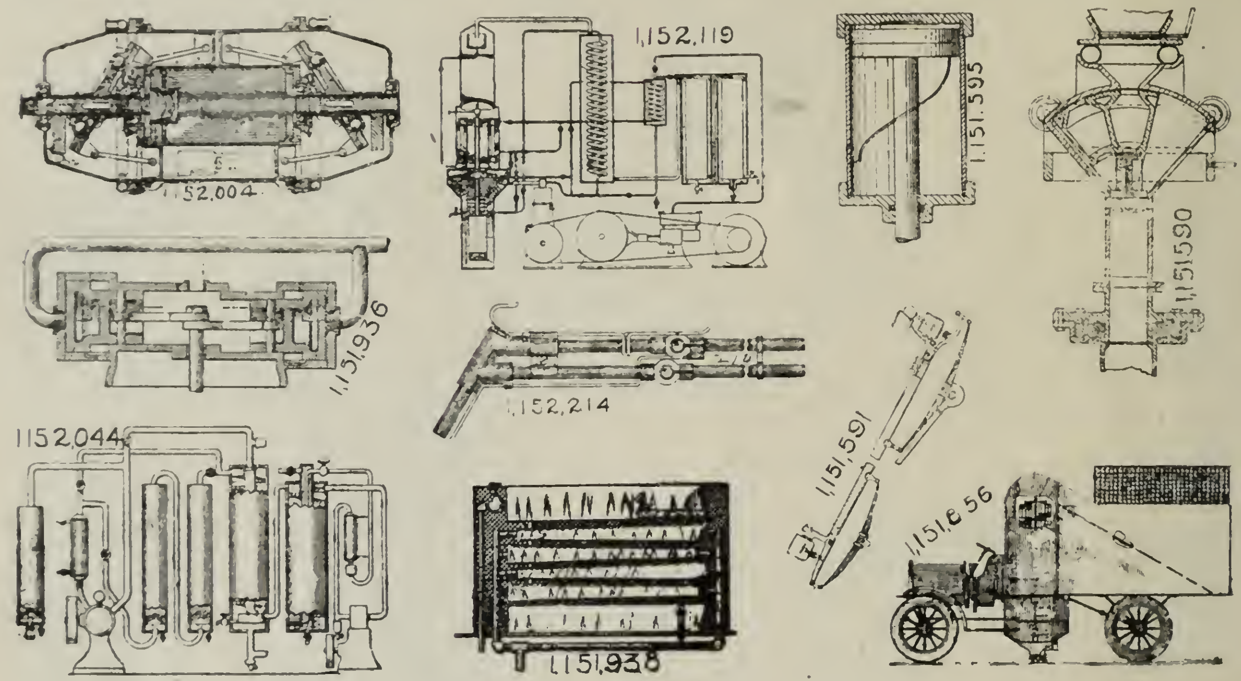
1,150,651. AIR-LIFT FOOT-PIECE. **Nobel W. Wood**, Brooklyn, N. Y.

1,150,786. APPARATUS AND METHOD FOR PRODUCING NITRIC ACID. **Harry Dalton Rankin**, Pittsburgh, Pa.

1. In an apparatus for producing nitric acid, the combination of a vessel adapted to contain air under compression, a head or disk operatively mounted therein and carrying electric conductors conveying current from a high tension induction coil, means to reciprocate and rotate said head simultaneously, a vessel connected with said first mentioned vessel, in combination with a high tension induction coil.

AUGUST 24.

1,150,866. VOLUMETRIC AIR-METER. **Otto A. Kreutzberg**, Lake Bluff, Ill.



Pneumatic Patents August 31.

1,150,915. UNLOADING SYSTEM FOR AIR-COMPRESSORS. **Oscar R. Wikander**, Pittsburgh, Pa.

1,150,950. VACUUM CLEANING SYSTEM. **Frank J. Matchette** and **Richard Raddatz**, Milwaukee, Wis.

1,151,406. METER FOR ELASTIC FLUIDS. **Thomas Scott**, Birmingham, England.

1,151,417. VACUUM-DRIER. **Francis J. Stokes**, Philadelphia, Pa.

1,151,464. SIPHON-BLOWER. **John Lawrence Houston**, Poughkeepsie, N. Y.

1,151,496. OXO-ACETYLENE WELDING-TORCH. **John G. Pettis**, Chicago, Ill.

1,151,510. PERCUSSIVE BOILER-TUBE CLEANER. **William Burlingham**, Newport News, Va.

1,151,540. AUTOMATIC AIR-INTAKE FOR SUBMARINES, &c. **Allen Hoar**, Long Beach, Cal.

AUGUST 31.

1,151,590. GLASS-MATERIAL-HANDLING APPARATUS. **Halbert K. Hitchcock**, Tarentum, Pa.

1,151,591. PNEUMATIC SPRING. **Josef Hoffmann**, Mont Pelerin, Switzerland.

1,151,595. EXPANSIBLE CHAMBER. **Samuel D. Ingham**, Philadelphia, Pa.

1,151,856 VACUUM STREET-CLEANER. **Patrick A. Bayless**, Oklahoma, Okla.

1,151,859. SECTIONAL AIR-BAG. **James P. Brophy**, Birmingham, Ala.

1,151,936. PULSATOR FOR PULSATORY TOOLS. **Arthur Henry Gibson**, Easton, Pa.

1,151,938. AIR-MOISTENER. **Robert W. Hardie**, Larchmont, N. Y.

1,152,004. FLUID-PRESSURE MOTOR FOR DRIVING TORPEDOES. **Georges Henri Marius Canton**, Billancourt, France.

1,152,025. VACUUM-CLEANER. **Julius Keller** and **Joseph H. Templin**, Philadelphia, Pa.

1,152,044. ART OR PROCESS OF LIQUEFYING AND SEPARATING AIR. **James F. Place**, Glen Ridge, N. J.

1. The art or process of liquefying atmospheric air consisting of or including the compressing of air substantially to or above its critical pressure, removing the heat of compression and absorbing moisture and carbonic acid gas therefrom; and then subjecting the same consecutively, to a succession of increasingly refrigerative actions—1st, to the cooling action of a counter-current of low-pressure expanded air below the normal temperature; 2nd, to the refrigerative effect of a liquefied gas released from pressure and evaporated; 3rd, to the cooling action of a counter-current of the vapor and cold-expanding gases evaporated from liquid air of substantially atmospheric pressure; and 4th, to the cooling action direct of said low-pressure evaporating liquid air—thereby liquefying said cooled compressed air while at substantially its critical pressure.

1,152,119-20. ART OR PROCESS OF LIQUEFYING AND SEPARATING MIXED GASES. **James F. Place**, Glen Ridge, N. Y.

1. The art or process of liquefying and separating a gaseous mixture, which comprises compressing and cooling the mixed gas; delivering one portion of said compressed mixed gas to a liquefier, and another portion to an expansion engine, and expanding the same therein against external resistance; and then liquefying the gas in the liquefier while under compression by the combined refrigerative effect of the cold expanded gas exhausted from the engine, and liquefied gas previously liquefied in said liquefier but released from pressure—both said released liquefied gas and said cold expanded gas being conducted over said liquefier so as to absorb heat from but not in direct contact with the compressed gases being liquefied therein.

1,152,214. BLOW-TORCH. **Ross M. G. Phillips**, West Haven, Conn.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. xx NOVEMBER, 1915 No. 11

THE MINING ENGINEER

BY W. L. SAUNDERS.*

This is a great day for the Institute of Mining Engineers. We are glad to be here. We are glad that we are alive; happy in the thrill of vitality which is quickened by California spirit and by the elixir of your glorious climate. On behalf of the Institute which I represent, I thank you for giving us this day. In thus honoring the Institute you are paying a tribute of regard and appreciation to the whole mining industry; to the lusty pioneer who blazed the trail and whose dry bones were the only monuments to mark the milestones of his progress; to the educated engineer and the capitalist whose skill and money were spent beneath the soil in daring efforts to release the hidden forces of Nature and put them to the service of mankind. You are paying tribute to the geologist, the chemist, and the metallurgist, for they, too, are mining engineers and members of this Institute.

I speak of California as a mining state; as such were you born. You received your baptism in the waters of the South fork of the American river when Marshall discovered gold at Sutter's mill in 1848. This was the beginning of the Golden Age for California and the world. The Golden Age means more than the age of gold; it is the age of progress, of prosperity and industrial renown and wealth; the age of railways and steamships, of the manufacture of steam-engines, of electricity, of the telephone, the telegraph, the automobile, the aeroplane, the submarine. All these were made possible—yes, they were initiated and installed—through means which were provided by the mining industry. The mining engineer has multiplied and replenished the earth through subduing it; he has released those forces of nature which have been hidden through countless ages; he has through the science of metallurgy and chemistry made it economically possible to widen and enlarge to enormous proportions the use and influence of these forces. Look into the modern locomotive and steamship and we shall see that almost every pound of their vital structure is a product of the mines. The lathe that fashioned the shaft is itself a product of the mine, and it gets its power to turn from coal mined by machines which are themselves products of the mines. You may say to all this that the art of mining is as old as the hills. Let me remind you that mining at low cost, mining low-grade ore, and doing these things on a large scale, and the art of reduction and treatment through metallurgy, are the accomplishments of the mining engineer of our time. This was the key which unlocked those forces which have been the impulse behind the great industrial progress of the world. This, too, has all been accomplished since the discovery of gold in California.

Let us review some of the facts of history. The first half of the nineteenth century was a period marked by little progress in industrial wealth. The world's output of gold from 1800 to 1835 varied from ten to fifteen millions of dollars annually. The yearly product of iron during this period was only between two and three million tons, coal less than fifty million tons, copper less than fifty mil lion pounds. There were no transcontinental railways, no great steamships, no battleships, no factory system of manufacture, no large corporations. The total gold product of the United States during the period mentioned scarcely reached one million dollars annually. Beginning about the middle of the century, when California set the pace by adding in a single year fifty, and even eighty millions of dollars to the gold of the world, there followed a steady and increasing progress made in the output of iron, coal, and copper. Railway building progressed on almost parallel lines; so, too, did the deposits in the banks of the United States. It is of interest to note here that the American Institute of Mining Engineers got aboard in 1871, and thereafter shared closely in growth and prosperity this march of industrial progress.

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*Address of the President of the American Institute of Mining Engineers, on Institute Day, Panama-Pacific Exposition.

The world's production of gold at the present time is over $450,000,000 annually. The United States alone now produces over 26,000,000 tons of pig-iron annually, and about 550,000,000 tons of coal. The world's yearly production of copper is now over 900,000 tons, and of this the United States produces over 500,000 tons. So, too, we find that the average per capita wealth of the people of the United States has risen from 300 in 1850 to over $1300. The influence of mining on wealth is conspicuously shown in the case of your neighbor, the State of Nevada, where the per capita wealth of her people is about $4800. Nevada is, strictly speaking, a mining state, with easy divorce laws to interest and allure the homeless and distracted mining engineer.

California has added more than $1,600,000,000 to the gold supply of the world. Her record average of over $25,000,000 in gold annually for 50 years is unprecedented. It has been estimated that the actual value of gold deposits should be multiplied eight times to get the true value in credit and capital: If this is true, then California has in her gold supply alone contributed over $12,000,000,000 to the capital wealth of the United States.

Gold is the standard of all values. It is the measure of credit, the basis of exchange. "Change and decay on all around I see," but in gold there is no change, no decay. The lure of gold has discovered continents and turned deserts into fertile lands. Gold was the beaconlight which led Columbus across the Atlantic. Cortez, Pizarro, Balboa, and others who are called explorers were really pioneers and prospectors whose voyages led to the early development of mining in Peru and Chile. But not till California led the way did the mine explorer become a world builder; he was the advance agent of prosperity.

The stability of this country in peace and in war is due mainly to the mining engineer. Our industrial strength comes from the mines, the mills, and the furnaces which are now so well organized on a peace basis and which have in their substance all the sinews of war. Military supremacy comes from the same elements as industrial supremacy: It is mainly a question of organizing the resources of the country. Of one thing we may feel sure and that is that no nation can ever make a scrap of paper out of a gold eagle.

You may crush, you may shatter the coin if
you will,
But the value of gold-dust remains with it
still.

It was because of the recognized importance of the mining and metallurgical industry that the American Institute of Mining Engineers was organized at Wilkes-Barre, Pa., in 1871. Following the War of the Rebellion and coincident with the development of the mining industry in the far western states, there arose a great demand for mining engineers. It was recognized that the chief factor in the development of the Western country was the mining industry: It created a romantic interest and it gave a stimulus to the people in general and even to Congress, which granted large subsidies for railway building. Scientific schools were established and technical journals disseminated engineering literature; but the mining men, those actually engaged in the mines and mills and smelters, were not organized: They needed a common ground for the exchange of ideas, a forum for discussion and education; and so the Institute was established. It was the second society of its kind following the organization of the American Society of Civil Engineers. The Transactions of the Institute cover geology, assaying, milling, smelting, mining, quarrying, and general construction management. The papers submitted at the meetings cover a wide field and are recognized by engineers and scientists throughout the world as of significance and value.

The Institute is incorporated under the laws of the State of New York, organized and existing with the object of promoting the arts and sciences connected with the economic production of the useful minerals and metals and the welfare of those employed in these industries by means of meetings for social intercourse and the reading and discussion of professional papers, and to circulate by means of publications among its members the information thus obtained. Its membership includes those who have worked their way up from the ranks as well as graduates from scientific schools and colleges. Leading professors and technical educators have always been prominent in its membership. The welfare and safety of the mine-workers is a subject of recent and earnest interest among the members and a new field of usefulness has been developed in using the power and the influence of the Institute wherever the industry represented by mining and metallurgy or the people engaged in the work may be benefitted through state or national legislation.

On behalf of the members of the American Institute of Mining Engineers, numbering now over 5000 and scattered throughout the world, I extend to President Moore, to San Francisco and to California, a full measure of warm congratulations and our best wishes for continued and increasing health, happiness, and prosperity.

THE MANUFACTURE OF LIQUID AIR*

The first real achievement in making liquid air into a commercial article was the patent taken out by Dr. Carl von Linde in 1895. In place of an expansion cylinder which had previously been used he employed a simple expanding nozzle, and made the cooling effect obtained by expansion through this nozzle the basis of his process. The cooling effect is very small, but was found in combination with a good regenerator to be quite sufficient. Actually at 17.1 deg. Cent. there is a drop in temperature of 0.225 deg. Cent. per atmosphere.

The action of the apparatus is simple. Air at a pressure of, say, 100 atmospheres is cooled as far as possible by water, and passed downward through a long spiral of copper tube. At the end of this spiral it escapes through the expanding nozzle, and its temperature at once drops by about 25 deg Cent. The cooled air then passes up over the outside of the spiral, and in its passage cools the air inside the spiral, which is descending toward the nozzle. The air arriving at the nozzle is therefore colder, and since the expansion through the nozzle makes it colder still, it is clear that a cumulative cooling effect is obtained which will reduce the temperature of the air below the nozzle further and further until it liquefies. In actual practice, using a copper regenerator, Linde obtained liquid air after two hours' running, one fifth of a gallon of liquid air being then obtained per hour. The pressures on either side of the throttle-valve were usually 200 and 50 atmospheres respectively.

It was this apparatus which formed the basis of Linde's patent of 1895 for extracting oxygen from air. Since the boiling point of nitrogen is 195.5 deg. Cent., and that of oxygen 181.5 deg. Cent., or 14 deg. Cent. lower, it seemed probable that if liquid air was slowly evaporated, its two constituents might be separated. In actual practice what happened was that vapors rich in nitrogen and oxygen respectively were given off by two different orifices, and by allowing a rather large proportion of the whole liquid air to escape through the first or nitrogen orifice, a gas containing some 50 or 60 per cent. of oxygen was obtained through the second or oxygen outlet. To accomplish the slow evaporation an extra coil of copper tube was fitted below the main regenerating spiral, and immersed in a small reservoir, containing the liquid air. The air leaving the regenerator passed into the small copper spiral, and gave up the remainder of its heat in evaporating the liquid air in the bath. It then expanded through the nozzle, liquefied, and dropped into the bath surrounding the spiral. Gradually, as things reached a settled state, the liquid in the bath, owing to the difference in boiling points, became rich in oxygen, while the vapors passing off became rich in nitrogen. The liquid and the vapor streamed over different parts of the regenerator on their way to their respective outlets, and the liquid in its passage turned into the gas rich in oxygen, already mentioned. A noteworthy economy in the process is the cooling of the air approaching the nozzle by that which has already passed the nozzle and been liquefied.

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*From *Engineering,* London.

Unfortunately this was the best separation which the apparatus could effect, and pure oxygen was not obtained until the brilliant applicaton by Linde, in 1902, of the rectifying tower. Other ingenious improvements, giving increased economy, have since been made by M. Claude, of the Société de l'Air Liquide, and these two apparatus, the Claude and the Linde, are those at present in use. M. Claude's plant is the more economical of the two, but in the smaller sizes requires rather more constant supervision. There has been considerable dispute, not altogether edifying, as to the merits of the two inventions, and the patents have been the subject of much litigation; but there can be no doubt that the two central discoveries on which the whole process rests—namely, the re-evaporation of the liquid air to separate it into its constituents, and the further separation of these constituents by means of a rectifying tower—are due to Prof. Linde. These two inventions are embodied in his patents of 1895 and 1902 respectively. On the other hand, valuable improvements, as explained below, have been effected by M. Claude, and considerable credit is due to him for his researches in connection with neon lamps, liquid oxygen explosives, and the production of exceptionally pure nitrogen. The whole affair, as regards the inventions themselves, was most ably summed up and elucidated by (the then) Lord Justice Fletcher Moulton in 1908, when passing his judgment on the appeal which was lodged by the British Oxygen Company against the British Liquid Air Company.

The action of the Linde oxygen separator for producing oxygen of 98 to 99 per cent purity will be understood by reference to Figs. 1 and 2. The regenerator spiral, as will be seen from Fig. 2, consists of three small pipes d, inside a large pipe c, one of the smaller pipes d being surrounded by a larger pipe e. The in-coming air is conveyed by the small pipes d to the smaller spiral d_1 which is immersed in the liquid oxygen bath B. From this spiral d_1 the air passes by way of the throttle-valve G to the top of the rectifying column A. Pure oxygen is collected at e_1, and passes through the regenerator by the pipe e to the outlet E. At F nitrogen containing 7 per cent. of oxygen is collected, and finds its way through the main pipe c of the regenerator, or interchanger, to the outlet C; b_1 is a gage containing a colored liquid to indicate the level of the liquid oxygen in the bath B, and J and K are test-cocks communicating with the liquid air and liquid oxygen supplies respectively. L is an emergency release-valve on the low-pressure system.

Before reaching the inlet D, which communicates with the delivery of the compressor, the compressed air has been cooled to —20 deg. Cent. by an ordinary refrigerating plant and has been purified of carbon dioxide by a slaked-lime purifier on the compressor suction. The purpose of the forecooler is to freeze out the atmospheric moisture; and if a forecooler is not used, a calcium-chloride drying tower must be placed in the compressor delivery. Even these precautions do not prevent freezing up, so that the forecooler and separator are generally duplicated. In practice, the separator takes about six days to freeze up, and the forecooler about two.

In starting up the plant, air at 2,000 pounds per square inch pressure is admitted at D, after being cooled and purified, and passes through the pipes d and the spiral d_1 to the throttle-valve G, whence it is discharged by the pipe d_2 to the top of the rectifying column A. It finds its way out by the collectors F and e_1, through the pipes c and e of the regenerator, to the outlets C and E. A step down in temperature, owing to the Joule-Thomson effect, takes place at the throttle-valve G, and a progressive cooling goes on till the air liquefies and gradually accumulates in the reservoir B. The pressure of admission is then reduced by degrees to the working pressure of 50 to 60 atmospheres by opening the throttle-valve G.

When the apparatus has steadied down to its work, the liquid air in the bath B is continuously evaporated by the hotter compressed air passing through the spiral d_1, the hotter compressed air being thereby further cooled and liquefied. This is in accordance with the description already given of Linde's 1895 apparatus. The vapors coming off from B will, as mentioned in the same description, be rich in nitrogen, while the liquid remaining will be rich in oxygen, owing to the boiling point of the nitrogen being 14 deg. Cent. below that of oxygen. We have therefore two opposing streams in the rectifying column; a downward stream which starts as liquid air at 81 deg. Cent. absolute at the top (emerging from pipe

d_2), and an upward stream which starts as a liquid rich in nitrogen at the bottom, being then at about 91.5 deg. Cent. absolute (the boiling point of oxygen).

The action of the rectifying tower and its baffle plates is to change the descending current into oxygen of 98 to 99 per cent. purity, which goes off at the outlet *E*, and to change the ascending current into nitrogen of 93 per cent. purity, which passes through the collector *F*. In the case of the gases ascending, the oxygen is constantly finding itself in contact with liquids, whose temperature farther up the tower grows lower and lower. It therefore condenses, and joins the downward stream as a liquid. At the same time, the nitrogen in the downward stream, which starts as liquid air, coming into contact with gases that grow warmer and warmer farther down the tower, and which are constantly giving off heat, owing to the condensation of the oxygen, gradually evaporates and passes upwards to the outlet *F*. The final result is as stated above; and there is, it will be seen, at each stage of the tower, a constant exchange both of substance and heat. The necessary temperature gradient, between 81 deg. Cent. absolute at the top of the tower, and 91.5 deg. Cent. at the bottom, is obtained by means of the Joule-Thomson effect at the throttle-valve *G*, the pressures on the lower and upper side of this being 50 to 60 atmospheres, and 4 pounds to 5 pounds per square inch respectively. The Joule-Thomson effect also accounts for losses due to leakage through the insulation (which is of sheep's wool cased in with timber) and losses due to the inefficiency of the regenerator. In practice it is found that the pressure of 50 to 60 atmospheres is just sufficient to fulfill all these purposes. It is also far more than is necessary to liquefy the air at the temperature of 91.5 deg. Cent. absolute, which exists in the oxygen bath.

The action of Linde's rectifying tower is similar to, and based on, that of the Coffey still for rectifying alcohol. In the Coffey still the wash, weak in alcohol, was admitted at the top, and steam was admitted at the bottom; while, after rectification, steam passed off at the bottom, and a vapor rich in alcohol at the top, there being, as before, an exchange at each stage both of substance and of heat.

Fig.1.

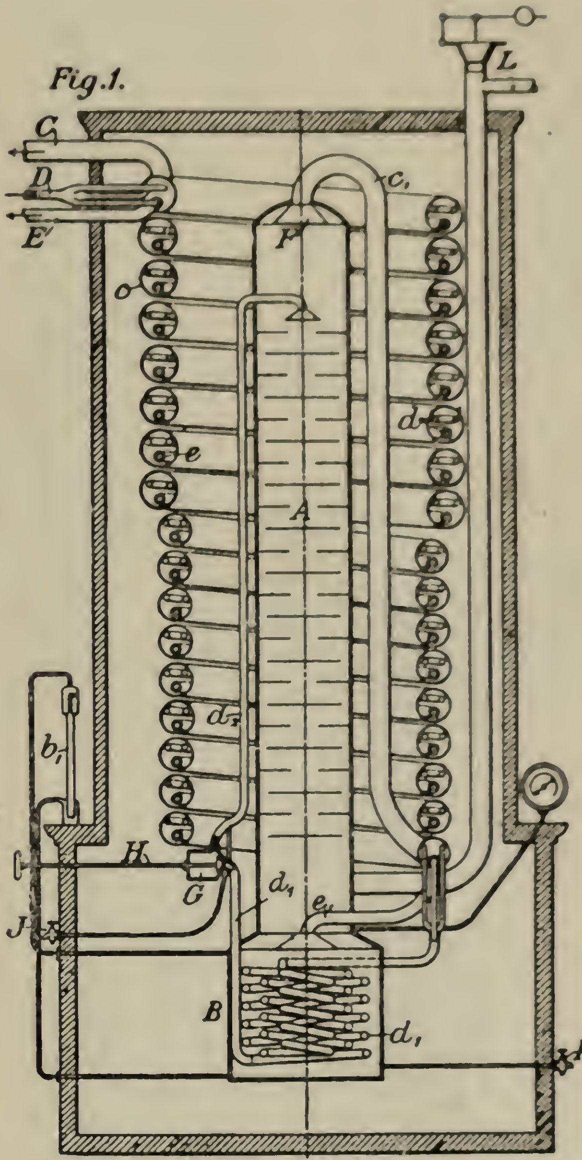
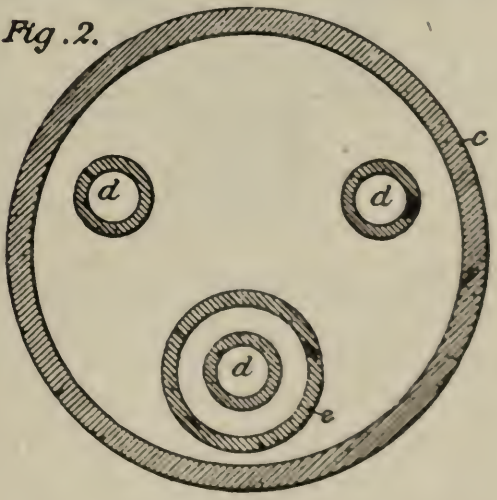


Fig.2.



In Coffey's apparatus the temperature gradient is provided by the excess in temperature of the steam over the weak alcohol wash, and

Fig. 3.

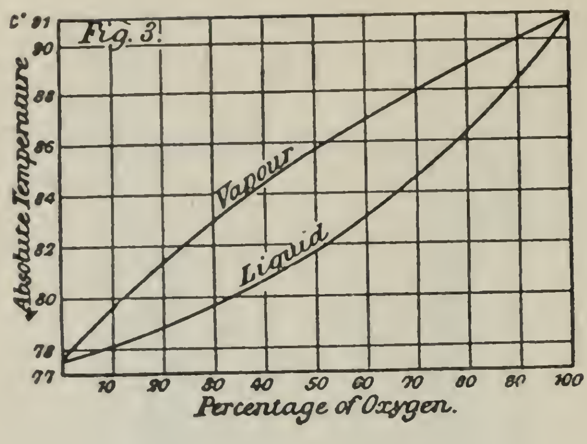
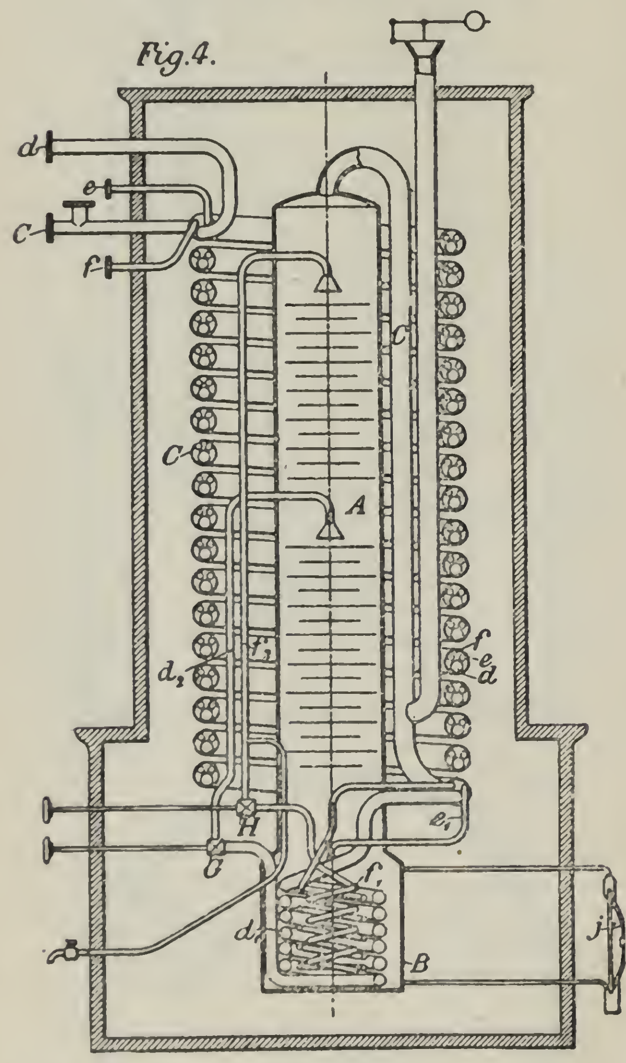


Fig. 4.



it is in this respect that Linde's apparatus, by using the throttle-valve to give the necessary step-down effect, differs from Coffey's.

It may be asked, Why should nitrogen of only 93 per cent. purity be obtained at the top of the tower? The explanation of this fact, and of the action of the tower itself, will be made clearer by reference to the experiments made in 1900 by Baly, on the nature of the evaporation in liquid mixtures of oxygen and nitrogen. In Fig. 3 the Baly curves, which exhibit the results of his experiments, are shown. Baly found that, given a mixture of oxygen and nitrogen in any definite proportion, equilibrium between the liquid and vapor is possible only when the vapor contains a definite proportion of the two constituents; but this proportion is not the same as that in the liquid mixture. The curves show the percentage which exist in the liquid and vapor respectively at various absolute temperatures. For instance, if the liquid mixture is half oxygen and half nitrogen, the vapor in contact with it will, we see from the curves, consist of 22 per cent. oxygen and 78 per cent. nitrogen. Similarly, when the liquid has the constituency of liquid air—namely, 79 per cent. of nitrogen and 21 per cent. oxygen—the proportion of oxygen in the vapor coming off will be a little less than 7 per cent. For this reason only nitrogen of 93 per cent. purity. can be obtained with the Linde rectifying tower described. And it is also easily seen that, since the ascending vapors are always richer in oxygen than they should be for equilibrium with the descending liquids which they meet, there must be a progressive condensation of oxygen from the vapor, and evaporation of nitrogen from the liquid, to enable that equilibrium to be established.

To meet the demand made for pure nitrogen by the cyanamide process, the Linde apparatus had to be modified, when used for producing nitrogen, to the form shown in Fig. 4, used in conjunction with two compressors, for low and high pressure respectively. The main regenerator spiral *C* incloses three spirals, made from smaller tubing, *e*, *f*, and *d*. *e* conveys the oxygen collected by the pipe e_1 to the outlet *e*. *C* conveys pure nitrogen from the top of the tower to the branched outlet *C*; the pipe *d* takes the delivery of the low pressure compressor to the liquefying spiral d_1 immersed in the oxygen bath *B*, and thence to the middle of the column by way of the throttle-valve *G*, and the pipe d_2; and, finally, the pipe *f* (which is generally replaced by several pipes) takes the delivery of the high pressure compressor to the liquefying spiral f_1, and, by way of the throttle-valve *H* and and the pipe f_2, to the top of the column. As in the oxygen apparatus, a forecooler and

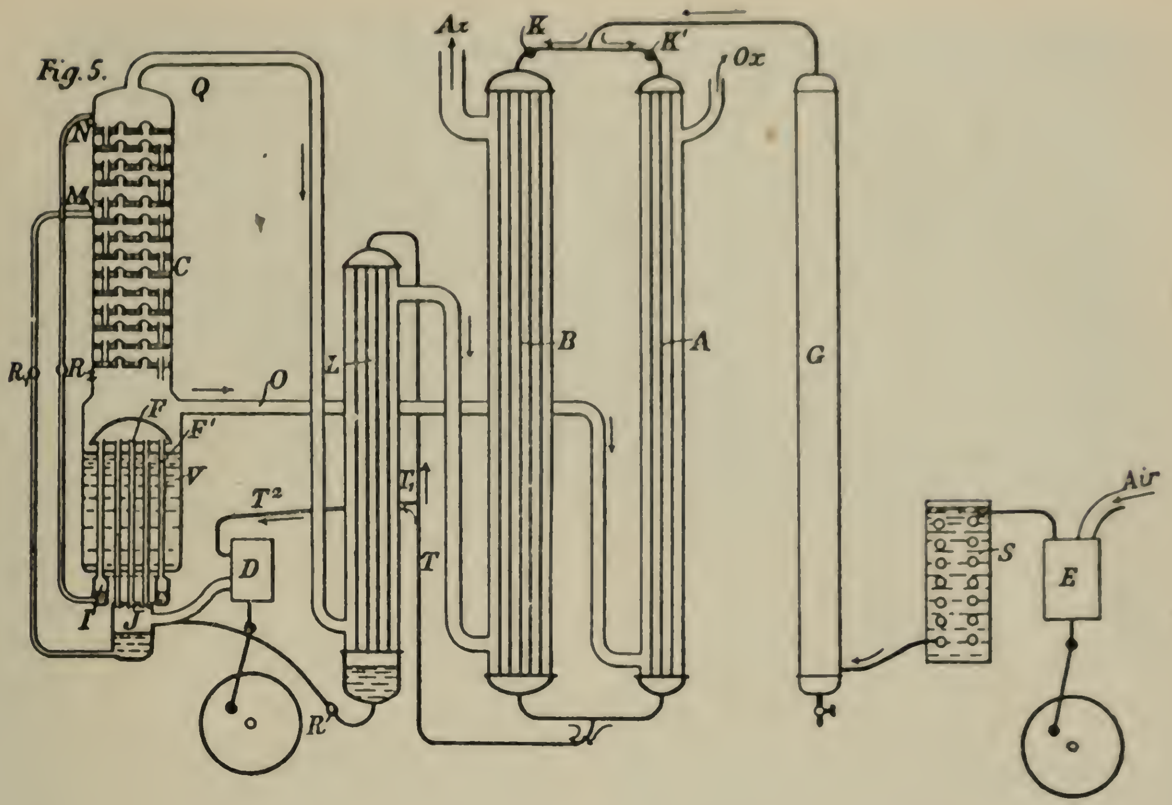


Fig. 5.

purifiers are used, and there is also a liquid gage *j*.

The preliminary cooling is effected either by charging the plant with liquid air separately made, or by compressing air at 2,000 pounds per square inch into the pipe *f*, and, after expanding it through the throttle-valve *H*, sucking it back again through the pipes *C* and *e*. In actual steady operation air is delivered from the low-pressure compressor at 60 pounds per square inch through pipe *d*, and throttled and discharged by pipe d_2, at the middle of the column, thus rectifying the vapors, which are ascending from the oxygen bath *B*, till they contain only 7 per cent. of oxygen. The rectified vapors escape by the outlet *C*, and a part of them is taken by a branch to the inlet of the high-pressure compressor. From the high-pressure compressor this portion is delivered to the pipe *f*, and discharged as a liquid containing 7 per cent. of oxygen by pipe f_2 at the top of the column. The effect, according to Baly's curves, is to rectify the ascending vapors, which have 7 per cent. of oxygen when they pass the outlet from pipe d_2, till they contain 2 per cent. of oxygen only. A part of the ascending vapors is once more taken from the branched outlet to the inlet of the high-pressure compressor, and discharged by pipe f_2, this time as a liquid containing only 2 per cent. of oxygen. The ascending vapors are thus rectified still further, till finally only pure nitrogen is given off. Part of this nitrogen continues to circulate through the high-pressure system for "scrubbing" or rectification purposes, but the major portion is collected for use through the vertical branch on the outlet *C*. The oxygen vapors meanwhile pass out by pipes e_1 and *e*.

The advantages of Claude's apparatus are, first, that by a progressive liquefaction of the air, he is able to obtain more complete separation than in Linde's oxygen apparatus; secondly, that by using a part of the incoming air to do work in an expansion cylinder, he obtains his drop in temperature more easily, and can do with an initial pressure of 25 to 35 atmospheres only, thus doubly economizing in power. The saving in power amounts to some 20 per cent., but is partially counterbalanced by the complication of the apparatus.

Fig. 5 shows the complete Claude plant. Air, after purification in slaked lime, is compressed and cooled, and passing through the calcium-chloride drier *G*, reaches the two regenerators *A* and *B*. The regenerator *B*, through which the nitrogen passes on its way to the outlet *Az*, is three or four times as large as the regenerator *A*, by means of which the oxygen arrives at the outlet *Ox*. The air at the bottom of the regenerators has a temperature of about —100 deg. Cent., and is then divided into two parts, about a quarter of it going by way of the pipe T_1 to the liquefier *L*, the function of which will be described later, and the remainder being admitted by a pipe T_2 to the expansion engine *D*. This engine is used to drive a dynamo, and the lubrication difficulty experienced by Siemens has been overcome by the use of petroleum ether. During expansion the temperature of the air falls to about —170 deg. Cent. (103 deg. Cent. absolute), and its pressure to about 4 atmospheres, which is sufficient to liquefy it at the temperature of 91.5 deg. Cent. absolute existing in the bath of oxygen.

Under these conditions the air arrives at the vaporizer *V*. The vaporizer consists of two sets of tubes, *F* and F_1, *all* connected at the top, but opening at the bottom into the receptacles *J* and *I* respectively. Air thus passes into *J*, up the tubes *F*, down the tubes F_1, and into the receptacle *I*, and in its passage it becomes liquefied, the part liquefied in the tubes *F* draining back into the vessel *J*, and the part liquefied in the tubes F_1 draining back into the vessel *I*. Vessel *I* will contain a liquid rich in nitrogen, and vessel *J* a liquid rich in oxygen. This will be clear if we consider that since the liquid condensing on the sides of the central tubes *F* is scrubbed by the up-coming vapor as it trickles down, the liquid and the vapor may be said to be in such close contact as to be in equilibrium. Hence, according to Bayly's curves, since the vapor contains 21 per cent. of oxygen, the liquid must contain 48 per cent. Of course, the liquid formed in the upper part of the central tubes consists mainly of nitrogen, but as it trickles down the interior of the tubes, exchanges of heat and substance take place between it and the ascending vapors, exactly as in the rectifying tower, so that all the liquid arriving at the bottom contains 48 per cent of oxygen. To this draining back M. Claude gives the name of "retour en arriere." When the 48 per cent. liquid is discharged into the rectifying column at *M*, it naturally produces a vapor which has the same composition as air (21 per cent. oxygen), so that the function of the part of the column between *M* and *N* is to take out as much of this 21 per cent. as possible. This is done by means of the liquid from *I*, which consists almost wholly of nitrogen, and is discharged into the rectifying column at *N*. Thus practically pure nitrogen vapor is given off by the pipe *Q*.

If this pure nitrogen vapor at a temperature of 77.5 deg. Cent. absolute were taken direct to the interchanger *B*, it would make the air so cold that it would enter the expansion engine mostly in the liquid state. Hence it is passed first through the liquefier *L*, and in liquefying a part of the compressed air the nitrogen becomes heated itself to —130 deg. Cent. (143 deg. Cent. absolute), and can safely be discharged into the interchanger *B*.

The compressed air liquefied in this way is expanded through the valve *R* into the vaporizer, and is known as the "liquide d'appoint." In practice about one-third of the air is discharged at *M*, and two-thirds at *N*, the *M* supply, as stated above, containing about 48 per cent of oxygen. In the *N* supply the proportion of oxygen is only about 6 per cent.

By a modification of his apparatus, M. Claude has been able to produce nitrogen of exceptional purity for the cyanamide work, such as is turned out by the Linde process already described. The tubes *F* and F_1 in this modification are led into one common receptacle instead of into the two separate reservoirs *I* and *J*. From this receptacle, as before, the liquid rich in oxygen is discharged at a point, such as *M*, into the rectifying columns. But the nitrogen, which condenses with difficulty in the oxygen bath in the ordinary apparatus, is taken off from the top of the tubes, and condensed in a small condenser situated about one quarter or one third of the way up the column, where the temperature is cold enough. It is then discharged as a liquid in a high state of purity at the top of the rectifying column, and rectifies the ascending nitrogen vapor to such an extent that they reach the outlet with a purity of 99.8 per cent.

In conclusion, it is interesting to note that the critical temperature of air, above which it cannot be liquefied, is —90 deg. Cent. (170 deg. Cent. absolute), and the corresponding critical pressure is about 40 atmospheres.

Re-condensed sea-water is the only available supply for the power-plant of the Chile Copper Co. at Tocopilla.

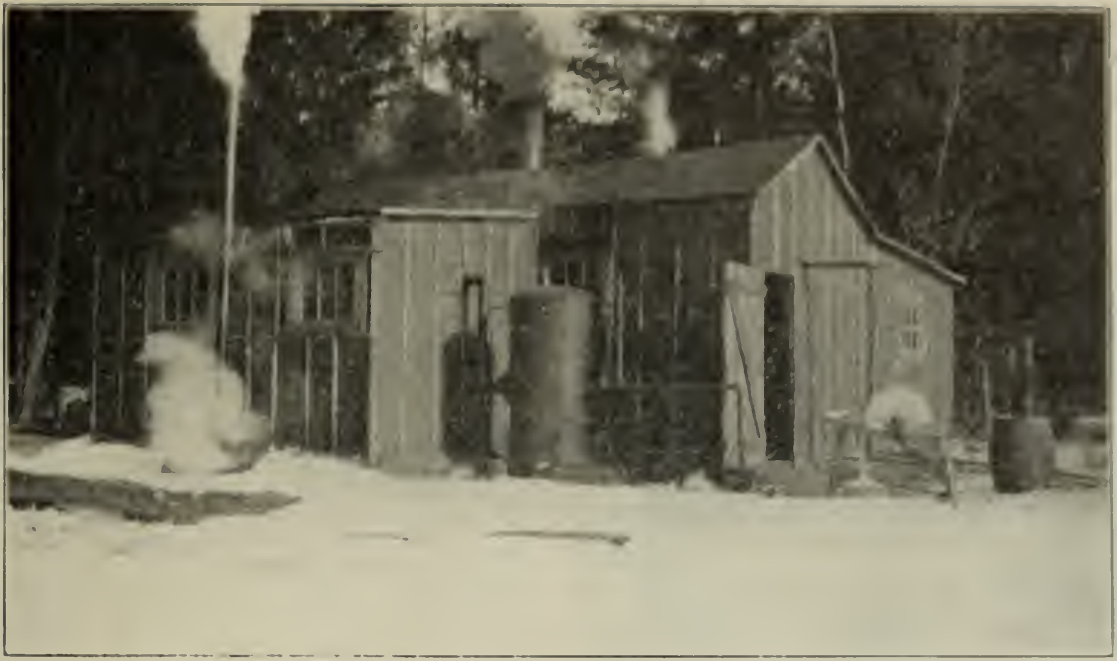


FIG. I. THE COMPRESSOR HOUSE.

THE JACKHAMER IN THE CONTRACTING FIELD

BY A. E. BUZZO.

I have been using a couple of BCR-430 Jackhamer drills in a rather novel manner which shall be described later on. It is my belief that the light, hand-held hammer drills for holes up to about six feet will accomplish more drilling footage than the mounted machines for several reasons: Primarily, as no mounting is required, there is no time lost in setting up. With tripod drills at least thirty per cent. of the working time is lost in moving, setting up, and adjusting. Also, under most conditions, only one man is required to operate the Jackhamer drill, as no helper is needed on the machine. However, as I will state below, due to extraordinary conditions, I have put a helper on each machine in going through a certain formation. Again, since the Jackhamer only weighs about 45 pounds, and rotates the steel automatically, it is easy on the operators and they enjoy the work more.

For about the first 600 feet on this job we encountered granite, which was of a pretty uniform character. This was comparatively light and easy work for the drills. Then we ran into a quartzite formation, which was extremely hard and very much fractured. This made it difficult to get holes to the required depth (most of the holes were drilled to 6 feet). There is where the Jackhamer drills showed their superiority over the heavier piston machines. When we ran into a split in the rock we simply had to stop and start another hole. With the Jackhamer it only took a few seconds to make the change, while with the tripod drill it would have taken at least 10 minutes, and, in our case, many times it would have taken considerably longer. Also, as we were always working in from 12 to 30 inches of water, it will readily be seen that it was easier to handle the 45 pound machine than to flounder about with the heavy tripod drill weighing five or six times as much, especially as we know that the smaller machine will drill as fast as the larger one when supplied with a good air pressure. We carry about 100 pounds air pressure, using a 10 and 10x10 in. Ingersoll-Rand straight line steam driven compressor. Incidentally, I have also used the Jackhamers operated with steam, and have found them very satisfactory; but I prefer the economy and good results obtained from the use of air for any large job.

As the rock was covered most of the distance with sand and gravel, we had to use a casing to protect the collar of the hole from sand washing in. We, therefore, shrunk a steel ring loosely on the collar of the drill steel, and over the 2 inch casing. The ring was loose enough on the collar so that the steel would not bind in the hole. We used this method going through the worst forma-

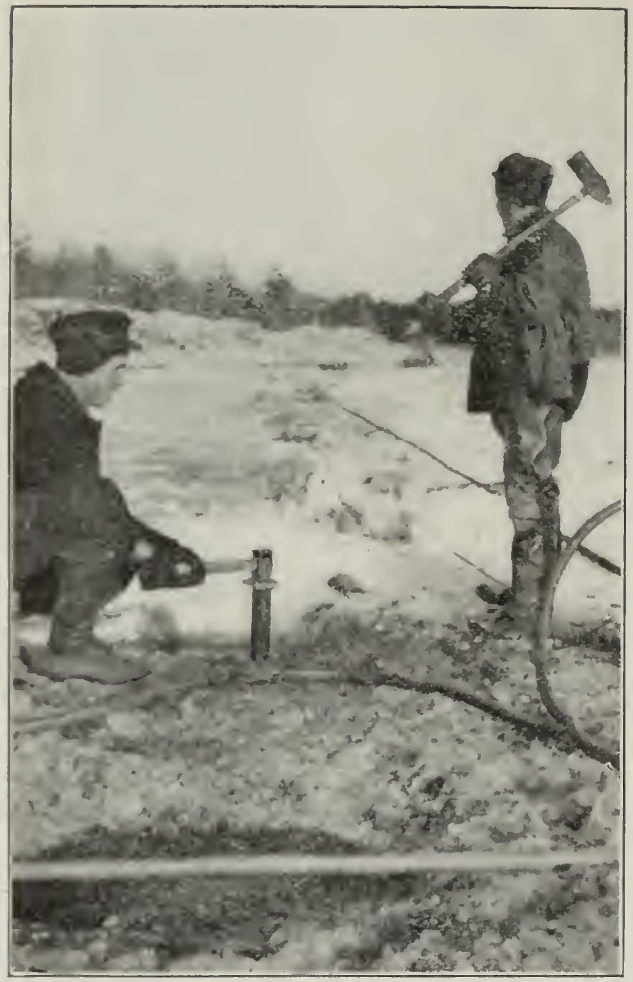


FIG. 2. DRIVING THE CASING.

tion, but as the rock was so badly fractured, I had to put a helper with each drill. He used a Stillson wrench to keep the steel rotating when it had a tendency to stick.

Of course, on account of these difficulties, a great deal of the men's time was taken up keeping the steel cutting properly, and, therefore, the drilling costs were much higher than they ordinarily would have been, and it is rather difficult to arrive at a definite cost figure. Yet, taking all obstacles into consideration, I figure that the Jackhamers have enabled me to do the drilling at about one-half what it would have cost me had I used the big machines. I have three 2½ in. piston drills here but did not attempt to use them against the Jackhamers.

This is a private drainage job designed to open up some fertile agricultural lands. During the winter the temperature was often 20 degrees below zero. We had some trouble with the hollow steel becoming blocked and freezing, but overcame this by keeping a fire handy and thawing it out. We took care not to heat the steel enough to draw the temper out of the bits. We used steel having the four-point cross bits, which gave sufficient clearance for the cuttings. I find the steel-retaining spring very handy when withdrawing the steel, also in keeping the hole free by churning the steel up and down; and the method

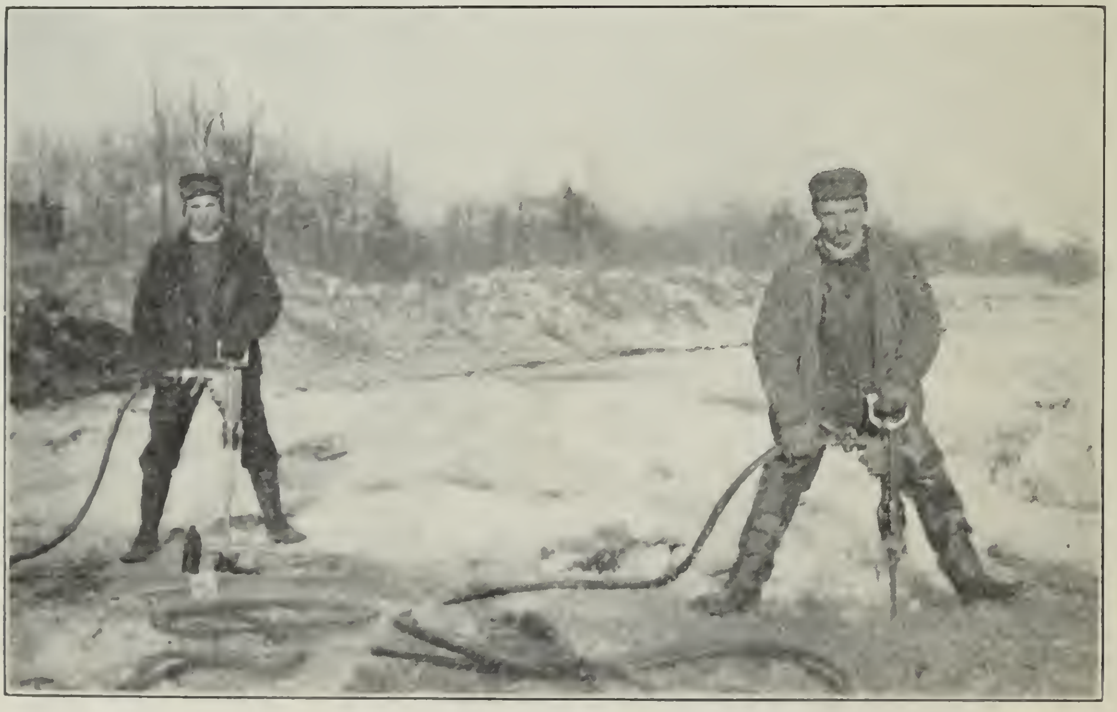


FIG. 3. THE JACKHAMERS AT WORK.

of keeping the bottom of the hole clear and throwing out the cuttings by means of exhaust air, is admirable

My repair costs have been negligible. My blacksmith paid particular attention to having the shanks of the steel square for the piston to hammer against, so that the tendency of the ends of the piston to chip off is quite eliminated. It has been my experience that even the much abused rock drill must be treated fairly well in order that it may give the best account of itself.

Aside from drilling rock, I found the Jackhamer very useful in the shop. We made a drag line bucket on which there was considerable riveting to do. Amongst my equipment I had another drill which was lying idle in the shop. In putting a patch on the dredge, the blacksmith had tried this drill for driving the rivets, and, at the same time, unknown to me, he had tried one of the Jackhamers. The Jackhamer proved very successful and he discarded the former machine. For the bucket job referring to, the blacksmith made a tool with a smooth surface, analogous to a blank rivet snap as used with a pneumatic riveting machine. The operator simply worked the Jackhamer around the rivet at different angles. We had air pressure on the forge and then it was all one man could do to furnish hot rivets to keep the Jackhamer going.

A JACKHAMER IN THE GOVERNMENT PRINTING OFFICE

BY W. R. METZ.*

The Drill mentioned herein was purchased under date of May 26, 1914, and has been in almost daily use up to the present time without having been sent to the shop for repairs and without being out of commission at any time.

On one occasion I had to remove a chimney foundation constructed of hard brick made in cement mortar. This foundation was twenty feet square by ten feet deep and was so hard that the bricks split before giving away at the joints. Three drills were used on this job, two being of another make, non-rotating, and one a Jackhamer with the rotating feature. The method used was to drill a row of holes, then drive wedges into the holes and split out sections. On account of the necessity of installing new machinery a new steel and concrete floor had to be constructed at a point directly above the top of the chimney base before the old foundation could be removed, so that the ordinary method of attacking the foundation from the top could not be adopted and the holes had to be drilled from the sides. The refuse material had, therefore, to be taken out of the basement in small trucks and up an elevator, which necessarily increased the cost of the work. The entire work was done at a cost of $15.00 per cubic yard, which was considered reasonable under the conditions. On account of the non-rotating feature the two other drills mentioned above required two men while the Jackhamer with its rotating action required only one man. The two other drills were also slower, requiring nearly twice the time to drill a hole 12 inches deep as did the Jackhamer. The Jackhamer drilled a 2 inch hole in three minutes, using fifty pounds air pressure.

This machine has also proved useful in drilling holes through the floors and ceilings of the building. The floor construction is of concrete and brick arches, with a two-foot space between the lower part of the arch and the ceiling below, this ceiling being constructed of concrete tiles. The space between the floor and the ceiling is used for carrying piping, electric wiring, etc., and it is, therefore, often necessary to drill a number of holes for installing machinery and lights, and the Jackhamer has long since paid for itself in this work alone. On floor work one man can drill a hole through the floor arch in two and one-half minutes, this arch being about ten to ten and one-half inches thick. On ceiling work it required two men on account of working on ladders or staging.

Another use of the Jackhamer is in replacing damaged bars or rods in chain-grate stokers. In our boiler house we use Babcock & Wilcox type chain-grate stokers, the general construction being small grate castings held together with one inch diameter steel rods, these rods extending the full width of the grate. In removing a damaged casting it is only necessary to drive out the rod, following up the same with a new rod, replacing the casting with a new one and driving the new rod clear through. This work was formerly done with heavy lead hammers and took about ten minutes to replace a rod; the work is now done with a Jackhamer in about two minutes. In this work the rotating feature is not necessary, but mention is made as I believe this is a new field for Jackhamer use.

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*Supt. of Buildings, Government Printing Office, Washington, D. C.

One of the main features of the Jackhamer and one of its best features is that it can be operated by air as well as by steam, and comparatively low air pressure can be used without serious disadvantage. For example: our building is piped up for air service in which air is carried at fifty pounds pressure. It would be a difficult matter to pipe up a building with outlets for hammer drills at each floor for high pressure steam.

This machine is certainly one of the handiest devices I know of for general use around a manufacturing plant and a machine driven by air as well as by steam and with the rotating feature, will pay for itself several times over in a single year.

BURNING OF ACETYLENE IN MINERS' LAMPS

When acetylene gas burns in air the gases given off by the flame consist of carbon dioxide (CO_2), and water (H_2O) in the form of steam, neither of which can be seen. In burning 1 cubic foot of acetylene, 2½ cubic feet of oxygen, or 12½ cubic feet of air (about 1 pound), is required; the products are 2 cubic feet of carbon dioxide, and 1 cubic foot of steam. As ordinary air is a mixture of oxygen and nitrogen and contains about 20 per cent. of oxygen, 10 cubic feet of nitrogen is left from the 12½ cubic feet of air needed to burn the cubic foot of acetylene.

The ordinary types of miners' carbide cap lamps use 12 to 14 grams (0.42 to 0.5 ounce) of carbide in an hour, and make 0.121 to 0.144 cubic foot of acetylene gas. In burning 0.144 cubic foot of this gas, 0.36 cubic foot of oxygen, or 1.8 cubic feet of air, is required, and there is given off by the flame 0.288 cubic foot of carbon dioxide.

In one hour the lamp in a confined space measuring 3 by 5 by 10 feet, or 150 cubic feet, would take from the air 0.36 cubic foot of oxygen, and add 0.288 cubic foot of CO_2, which, added to the 0.006 cubic foot (or 0.04 of 1 percent.) of CO_2 in 150 cubic feet of ordinary mine air, would total 0.294 cubic foot, or 0.196 of 1 per cent. of CO_2. In 10 hours 2.88 cubic feet of CO_2 would be added; this added to the 0.006 cubic foot of CO_2 normally in the air would make 2.886 cubic feet of CO_2, and the atmosphere in the space would contain 1.9 per cent. CO_2 and about 16 per cent. oxygen.

In unventilated parts of mines the diffusion of the gases in the air would prevent the CO_2 from the lamp becoming a dangerous quantity during a working shift.

A miner at moderate work draws into his lungs about 80 cubic feet of air in an hour and takes from this air about 3.2 cubic feet of oxygen; he exhales about 2.56 cubic feet of carbon dioxide, or over 8.8 times as much carbon dioxide as is given off by the flame of a carbide lamp.

Miners' Circular 18, *Bureau of Mines*

GUNITE FOR MINE WORK

BY STEPHEN ROYCE.*

The application of Gunite, or "Gun-crete" as it has been called, to mining operations is comparatively recent. Gunite may be defined as a mixture of sand, cement and water blown on a solid surface by compressed air forcing it through a hose and nozzle. An essential part of the gunite coating is the use of some form of reinforcing wire to be applied to the surface to be coated before the cement is blown on.

The places in which gunite has been used on the Gogebic range are the Cary "A" shaft, at Hurley, Wis., and the 18th level pump house of the Sunday Lake mine, Wakefield, Mich.

The cut shows a cross section of "A" shaft, and a longitudinal section, as well as details of the method adopted in applying the cement coating and its reinforcing. "A" shaft is a steel 5- compartment shaft, sunk to a depth of 1320 ft. in the quartzite. The steel sets are blocked in place with wooden blocking, and the lining of the shaft consists of 3-in. tamarack plank wedged into the flanges of the I-beams, which form the wall plates and the end pieces.

The purpose of the gunite coating in "A" shaft was, first, to fireproof the lathing and wooden blocking; second, to protect the lath-

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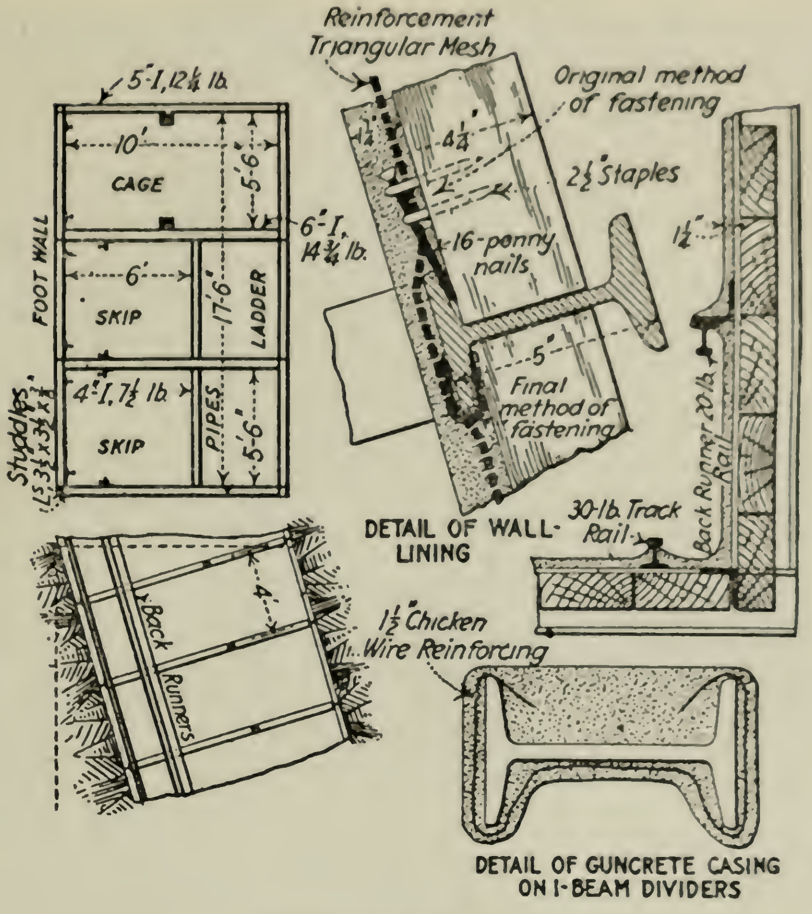
*General Engineer, Pickands, Mather & Co., Gogebic Range. Proceedings Lake Superior Mining Institute.



GUNITE IN MINE WORK.

ing from contact with the air in the shaft, so retarding its decay; third, to form an air and waterproof coating over the shaft lining, keeping air from entering the space between the timbers and the rock, and keeping in the water which is flowing along in the same space. This last feature is expected to retard the decay of the blocking as well as the lathing as this will be water-logged all the time. The gunite coating, by reason of its wire reinforcement, is expected to reinforce the lathing and partially take its place in the event of decay actually occurring. The coating was applied not only to the walls of the shaft, but also to the steel dividers, the intention being to protect these from rust and incidentally reinforce them after the manner of a reinforced concrete beam.

At Sunday Lake the purpose was to fireproof the pump house, which is timbered with heavy wooden posts, caps and lagging, and to protect the wood from dry rot, which at the high temperature in the pump house, quickly attacks it.

The application of the gunite coating in "A" shaft was done in two experimental sections, one being from the collar of the shaft to the 3rd level, the other from the 8th to the 10th level. In the first the machine was placed on surface and the hose lead down through the shaft to the point of application; in the second the machine was placed on the 8th level.

The first step in the application of the coating was to clean thoroughly the entire surface to be covered, which was done partly with water under heavy compressed air pressure, partly by sand blasting and partly by chipping the rust and accumulated coating off the steel. Next the reinforcement was applied. This consisted of No. 7, American Steel & Wire Co.'s triangular mesh reinforcing wire for the side walls.

An important point in the application of the reinforcing wire is that it should be separated by a short distance, say one-eighth of an inch, from the surface to be covered. This is so that the cement can get in behind the reinforcing and form a unit with it. This was accomplished by stapling the reinforcing wire on with nails under it. The I-beams, before the cement was applied, were covered with 1½-in. mesh chicken wire, clamped on with wire clamps. The dividers were filled in completely on their upper faces resulting in their reforcement for bearing a downward load. This increase in strength we figure at nearly 20 per cent. The work progresses downward and it was found best to coat the entire sidewalls before coating the dividers. The thickness of the coating in "A" shaft was 1½ ins. and it was found that the operator was able to gauge this thickness with astonishing accuracy. The cement was applied in from two to three coats.

The Sunday Lake pump house was coated with 1½-in. coating of gunite, over all the posts, lagging and exposed timber. This was applied over a reinforcing, consisting of 1½-in. mesh chicken wire on the posts, and a No. 7 reinforcing wire, triangular mesh, on the lagging in the roof.

The results so far observed have been excellent in both places. In "A" shaft we have a hard, fairly smooth, waterproof coating, which does not crack with the jar of the shaft in hoisting, and which we believe will greatly prolong the life of the shaft at the points where it has been used.

An interesting feature of our use of the cement coating is the wide difference between the temperatures to which it is subjected. At the collar of "A" shaft the cement is covered with frost and subjected to a temperature considerably below zero. In the Sunday Lake pump house the temperature at 5 ft. above the floor is 111°, and this must rise greatly near the roof of the pump house.

The cost of lining "A" shaft as described came to $9.2978 per linear foot of shaft. The total area of wall surface covered was 14,260.90 sq. ft., the total area of steel covered, measured along the contact of the cement with the steel was 3749.96 sq. ft. The material used was as follows: Sand, 102½ cu. yds.; cement, 173 bbls; reinforcing, 14,260.90 sq. ft.; chicken wire, 3749.96 ft. Fastening staples and wire were also used.

The work was accomplished by one foreman and six men in 32 working days. The total linear feet of shaft covered was 263.13. The Sunday Lake pump house, which was done under especially hard conditions, was considerably more expensive per square foot. This was done on contract by the Cement-Gun Construction Co. of Chicago. "A" shaft was an easy shaft for the application for the cement-gun coating as there was comparatively little water flowing on the surface of the lathing which was to be covered. If the cement can once be applied and can harden, no amount of water will make any difficulty thereafter, but there are considerable difficulties in making the coating stick to a wet surface.

GROWING USE OF COMPRESSED AIR IN COAL MINES

Experience suggests that there is a tendency with quite a number of colliery engineers to again revert to the use of compressed air underground in preference to electricity, as it is being more generally recognized that the air compressors of the present day are a very different article from the type of air compressors installed twenty or thirty years ago. The higher efficiencies obtained and the better training that the present-day engineers have, make them more alive to the arrangements they must provide in collieries for the efficient use of compressed air. The plant, therefore, now installed in any up-to-date colliery is in itself better suited to its conditions, and the air which it may deliver is used in a much more efficient manner. With these two leading differences, there is no doubt whatever that there has been, and is likely to be more so in the future, a tendency to have more and more air used in underground work, and especially where there is danger from gas or other reasons likely to cause explosions, such as may take place through any accident or other cause in the use of electrical plant under similar conditions.—*Colliery Guardian, London.*

In the hottest weather of the summer there is special trouble in the printing offices of the great newspapers and elsewhere. This is because of the softening of the gelantinous inking rollers, and arrangements must be made to keep them cool. An electric driven fan ventilating set, built by the B. F. Sturtevant Company, is proving highly satisfactory for the purpose and is being extinsively employed.

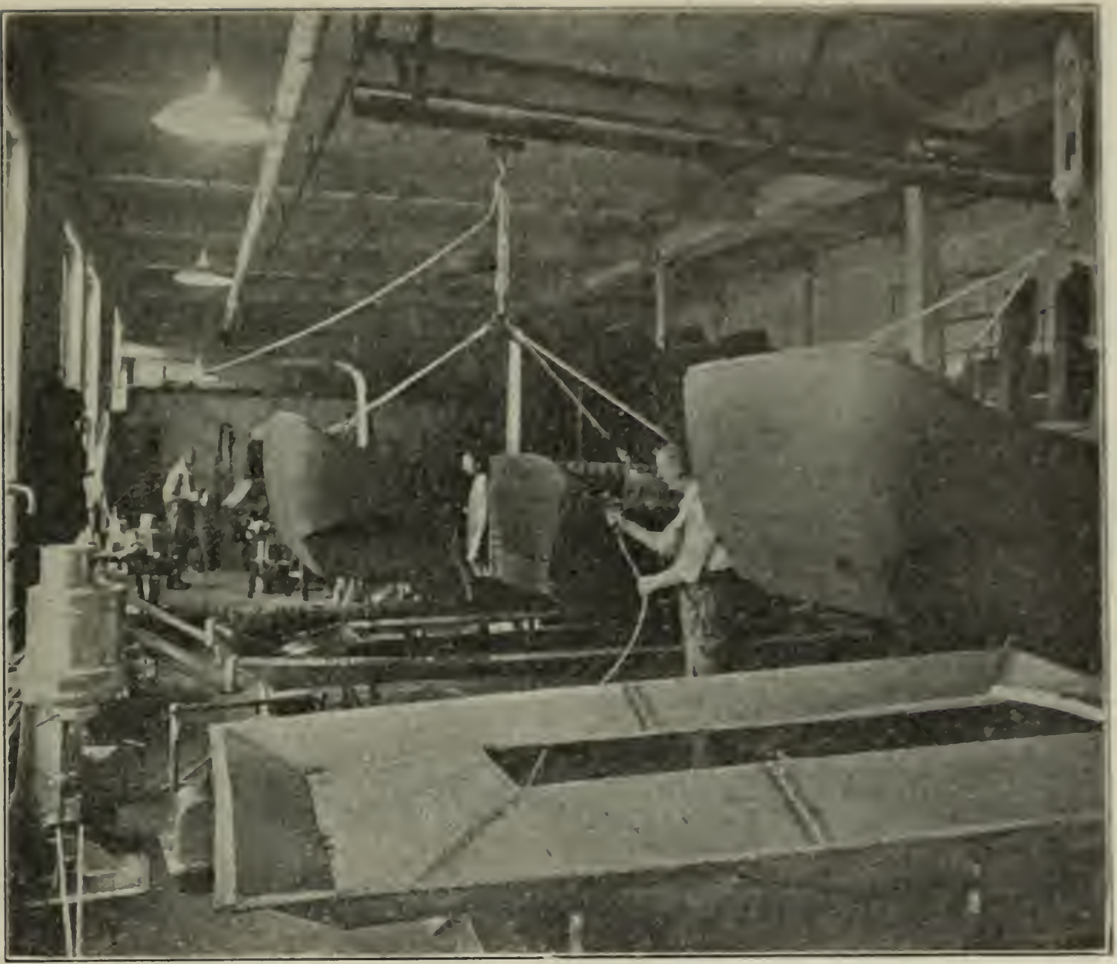


FIG. I. VARNISH APPLIED BY FLOWING NOZZLE.

COMPRESSED AIR FOR FINISHING THE AUTOMOBILE

BY GEORGE D. BABCOCK.*

In line with the modern improvements of machinery and methods for mechanical work there has been a development no less marked in the art of applying decorative and protective coatings to various surfaces.

Applying coatings with an atomizing air brush has only within the last two years reached a prominent position in industrial work. More recently still, in fact practically a development of the last year, has come the process of stream flowing of varnishes. This process is the application of liquid coatings by means of a wide flat nozzle through which the coating is forced to flow continuously upon the surface in a wide ribbon-like stream.

As in all new processes skepticism early took the place of scientific study, and the question of durability, cleanliness and brilliancy were long debated before the present practical adoption of the methods. The virtue of these late methods has been proved conclusively for each of the above-mentioned points.

The protection of the exposed surfaces of automobiles from the elements affecting them has required most intensive study since the beginning of the industry. Different kinds of soils, as well as different conditions of air, do not act alike on protective coatings. The continuous exposure of these coatings on the automobile requires that they be not only perfectly prepared and applied, but selected to resist the special destructive influences.

Japanning or painting aluminum surfaces presents now no particular problem to secure permanency and luster. Steel and wood have long since ceased to be troublesome.

Ten-day rubbing varnishes are dried in four and one-half hours with improved luster, cleanliness and durability.

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*Production Manager, H. H. Franklin Mfg. Company, Syracuse, N. Y., builder of the Franklin automobile. Article condensed from Iron Age, Oct. 7, 1915.

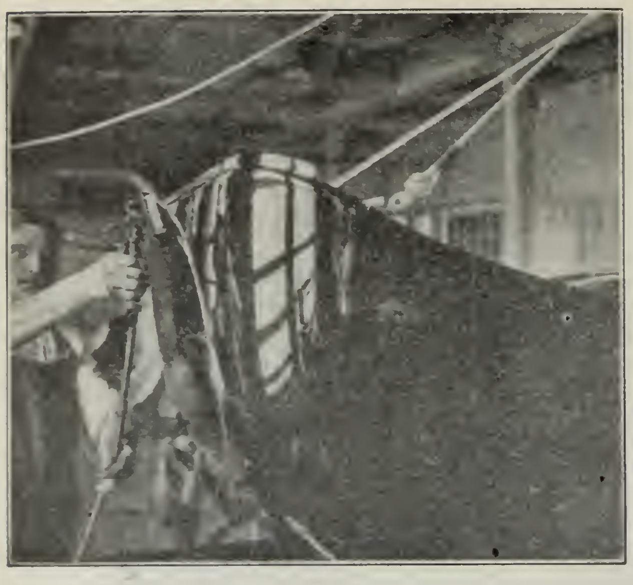


FIG. 2. FLAT STREAM CLEANS AND VARNISHES.

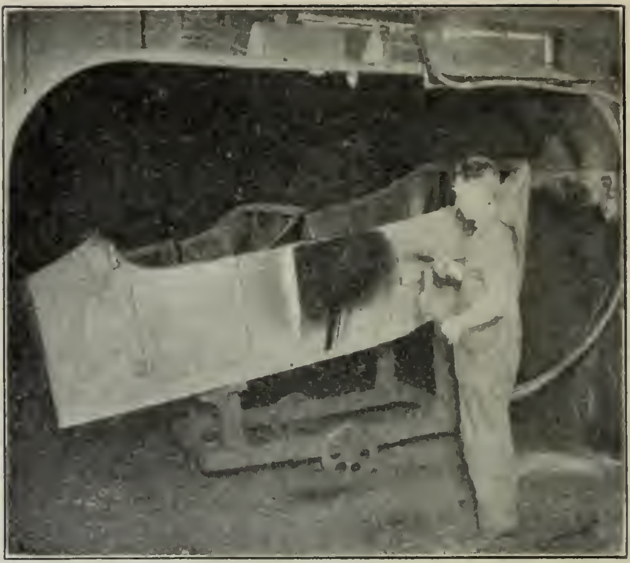


FIG. 4. HOOD FOR AIR BRUSH PAINTING.

The flowing of varnishes with the nozzle method leaves a coating as thick as will adhere to the surface.

Air drying required many coats relatively thin. High temperature drying, with humidity control and frequent air changes, gives better results by a thoroughly oxidized, tough, thick, varnish film. After such drying the film does not seem to crack or "alligator" as do numbers of thin air-dried coats.

Figs. 1 and 2 show how the flowing of the automobile body is done. Brewster green color varnish is used with the DeVillbus Floco equipment. The top outlines of the body are first brushed, to prevent spattering on the interior, and then the wide flowing nozzle is passed over the entire surface until the varnish not only washes off any dirt upon the surfaces, but flows in a thick uniform coat. The body is then allowed to drip and after a short period of air drying is put into the drying ovens, Fig. 3, which are heated and humidified by the Greeff Engineering Company's equipment. This varnish coat dries in four and one-half hours. The varnish which drips from the body flows back through a filter into a retainer, and at frequent intervals it is separated by means of a De Laval Separator, as shown in Fig. 1. This cleanses the varnish and it is used repeatedly; the new varnish being continuously added to that in use. In the far rear of Fig. 1 is shown the so-called roughstuff coating of the hoods by means of the atomizing air brush, after which they are coated by flowing as are the bodies.

Fig. 4 shows how the lead coat is applied with the DeVillbus atomizing air brush. A ventilating hood covers the work to take off the fumes. In the rear of the hood is the electric suction fan, and at the top of the hood may be seen the electric lamp enclosures for close illumination. One hose to the brush leads from the air pressure tank and the other from the liquid finish to be

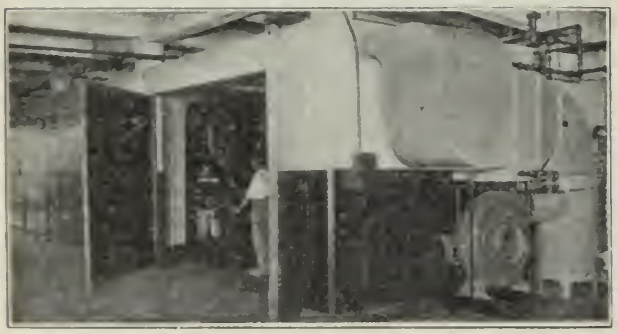


FIG. 3. DRYING OVENS.

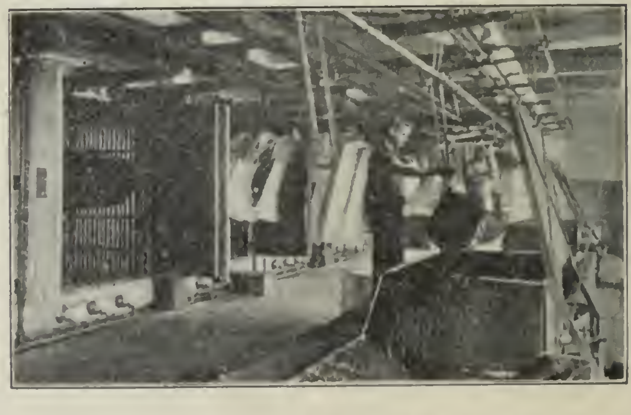


FIG. 5. PARTS CARRIED ON TROLLEYS.

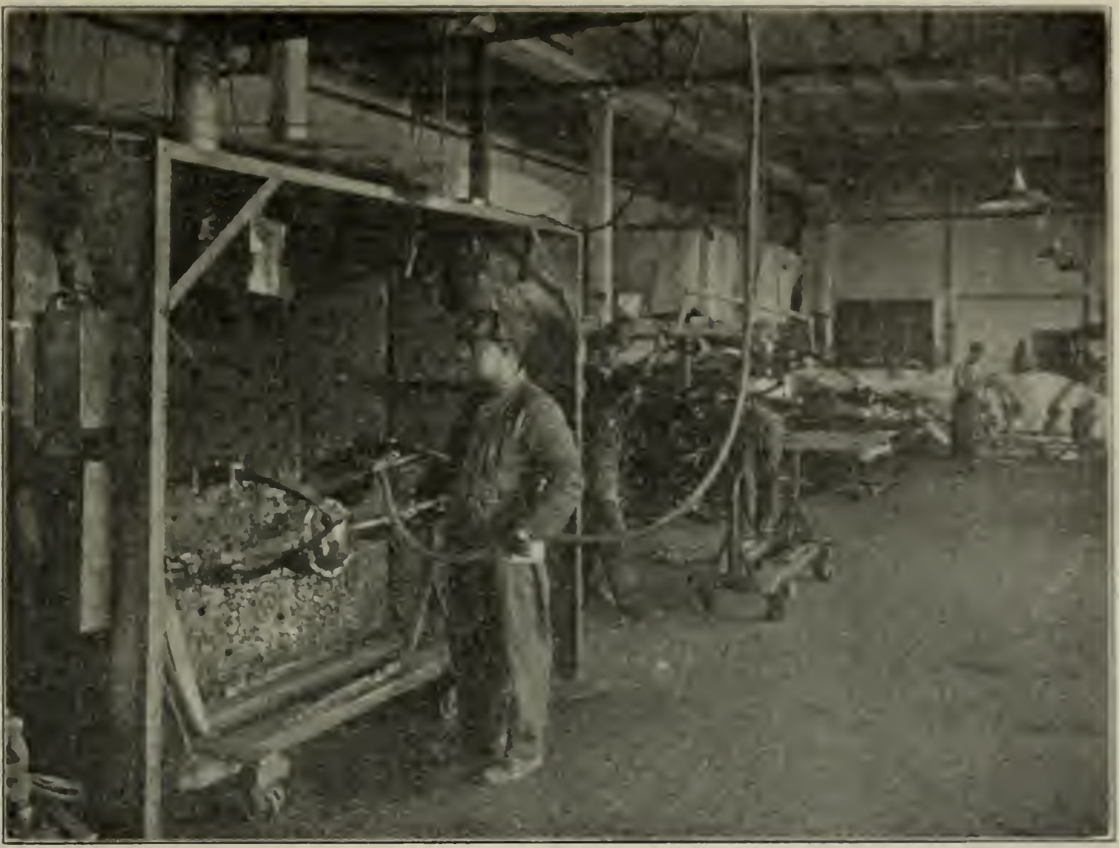


FIG. 6. AXLES CARRIED ON SPECIAL BUGGIES.

applied. The air brush spray is moved rapidly over the surface and gives a smooth uniform stippled coating. (The run, as it is called, shown in the photograph, was due to the operator's holding steady for the photograph.)

Wheels are charged to an air brush hood by means of the rolling conveyor as shown on each side of the hood in Fig. 7. After the varnish coats are applied the wheels are placed in a revolving dryer, where the varnish is allowed to set by air drying. The uniformity of the coat is maintaned by the continuous rotation of the wheels. After air drying, the wheels are heat dried in ovens.

Fig. 6 shows how the axles are finished, all coats being given with the air brush.

Japanning plays an important part in the protective coatings of an automobile. After dipping in the japans, the parts are hooked upon trolleys, as shown in Fig. 5, suspended by brackets from the ceiling and allowed to drip over the pans. They are then run into the drying ovens and baked. The indirect Gehnrich ovens, shown in this illustration, do not allow the burnt gases to act upon the japans. All products of combustion are carried up the sides of the ovens in the tubes as shown. There are no draughts needed in the oven to maintain the burning gas, and therefore none of the dust from the room is carried into the oven and deposited on the work.

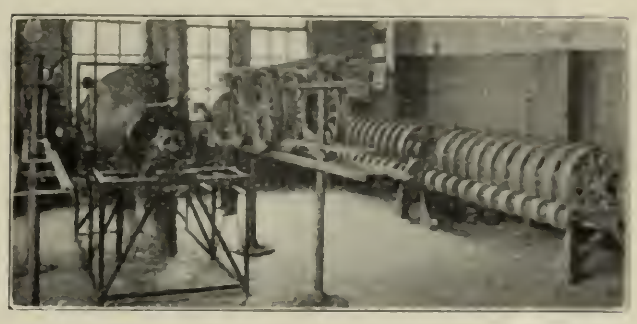


FIG. 7. ROTATING WHEELS FOR DRYING.

Poona is a mountain sickness that attacks people at an altitude of 11,000 ft. in the Andes of Argentina. These mountains are quite different to the Sierra Nevadas in North America. A height of 10,000 ft. is trying in the Andes, but in Mexico this elevation is unnoticeable.

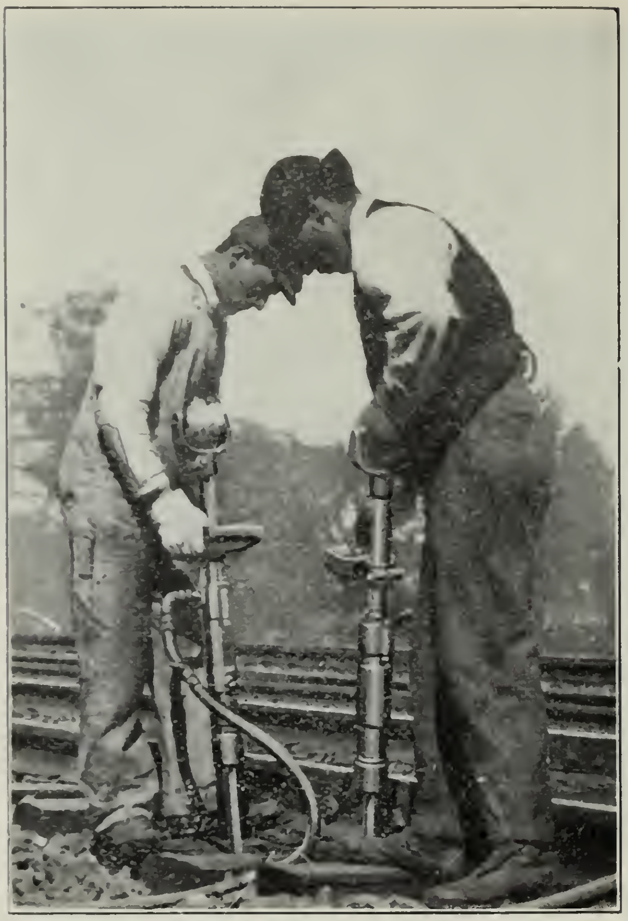
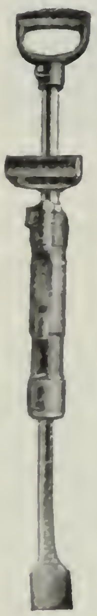


FIG. I.

THE PNEUMATIC TIE TAMPER*

BY W. H. ARMSTRONG.



We are probably well agreed that the tamping of rock ballast is the most arduous and fatiguing of track work. I am to direct your attention to a new track appliance which relieves the track laborer of his most strenuous and unwelcome task, and gives a better and more uniform quality of work at a great reduction of cost.

The Pneumatic Tie Tamper here to be spoken of is operated by compressed air at ordinary pressures, and works on the principle of the familiar pneumatic riveter. There is a piston or hammer which delivers sharp blows as rapidly as 800 per minute on the end of the tamping bar or steel which is inserted in the nozzle or lower end and is held in position by a secure locking arrangement which prevents its knocking out and also enables the operator to lift it from one position to another as is constantly required in the progress of the work.

The face end of the tamping bar or steel is similar to the tamping face of the ordinary hand tamping bar or pick. That is it is, say, ½ in. thick and 3 in. wide for heavy rock ballast; ⅞ in. by 3 in. for crushed stone or gravel, and 1⅛ in. by 3 in. for cinder or dirt ballast.

In operation the face of the tamping bar remains upon the ballast while the hammer blows are showered on the upper or shank end of the bar, and the action is to shove what ballast is covered by the face of the bar under and to the center of the tie. Then it is lifted back and the operation is repeated until the ballast is filled solid under the entire length of the tie. The best results are obtained by working the tampers in pairs or upon opposite sides of the tie at the same time as shown in Fig. 1. The method in this respect is practically the same as when using the old tamping bar.

The tamping machine complete with the tamping bar weighs 37½ lb., and as it is always held in a nearly vertical position the weight is sufficient feed for it without exertion on the part of the operator. The weight also absorbs the vibration of the machine, thus making it very easy to hold. The machine has two handles so located as to balance it to the correct height and position and enables the operator to stand erect while working.

The men like to use the machines as they find them much easier than the hand tamping bar or picks. When I questioned a track laborer on this point, the other day, he said, "I like best the machine because it no make me sick in the back."

The machine tamping is much faster than hand tamping. Two men should tamp a tie at both sides, inside and outside the rail in two minutes. It is more uniform, because the blows are just the same all day long, and, the blows being struck on the upper or shank end of the bar, it can be inserted between switch points, under frogs and around interlocking switches and do good and effective work where it is impossible to tamp properly with

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*Condensed from Paper before the Roadmasters and Maintenance of Way Association.

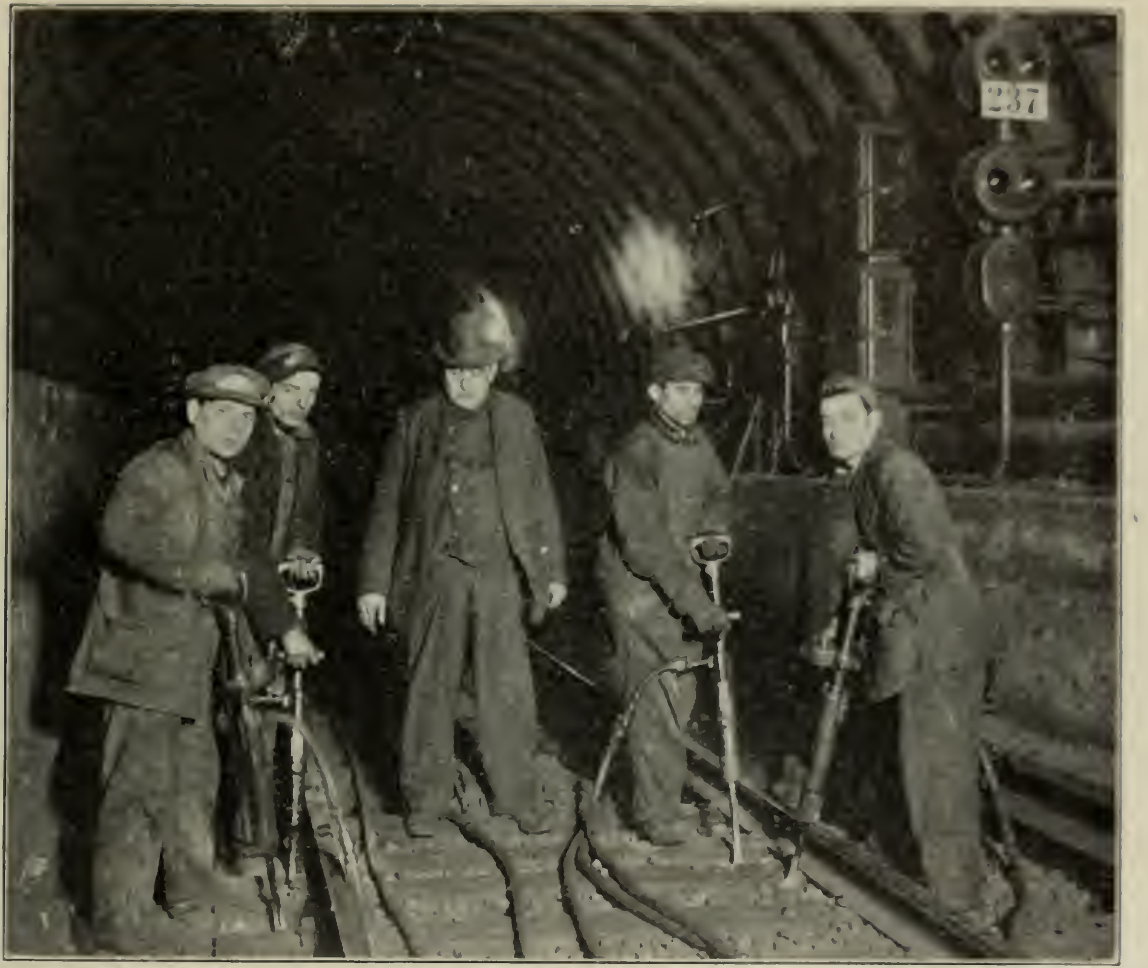


FIG. 2.

hand picks or bars. Fig. 2 was taken in the tunnel of the Hudson & Manhattan Railroad in New York.

It may be claimed as an additional recommendation for the air tampers that, aside from their working faster and doing better and more uniform work, they do not crumble or break up the ballast as badly as the hand picks, nor do they sliver the ties.

In terminals and car yards and at other points on railroads where electro-pneumatic signals are in use, or where charging air lines are maintained, the machines can be operated successfully from these air lines without interfering in any way with the signals or other work, and also with good economy, due to the fact that the portable compressor is dispensed with.

For outside or line work where there is no air on tap, there is provided a gasoline-driven air compressor plant which is self contained and self propelled, taking the place of a section motor car and capable of being shifted off or on another track in the same way. It will carry twelve men at a maximum speed of 15 miles per hour. The gasoline engine is 12 h.p. and the compressor will easily supply two of the tamping machines.

For electric railroads and for street railways an electric driven outfit takes the place of the gasoline machine.

The first experiments with pneumatic tampers of this type were conducted on the West Shore Railroad of the New York Central Lines. With two of these machines they tamped 800 ft. of track at Granton Station, River Division, and an equal distance on parallel track was tamped by hand. This was not an ideal location for a trial of this kind as the foundation was built over the Hackensack Meadows, and consequently was soft. This was before the portable air compressor had been developed and the location was selected as the only place where air was readily available.

A careful examination of the two portions

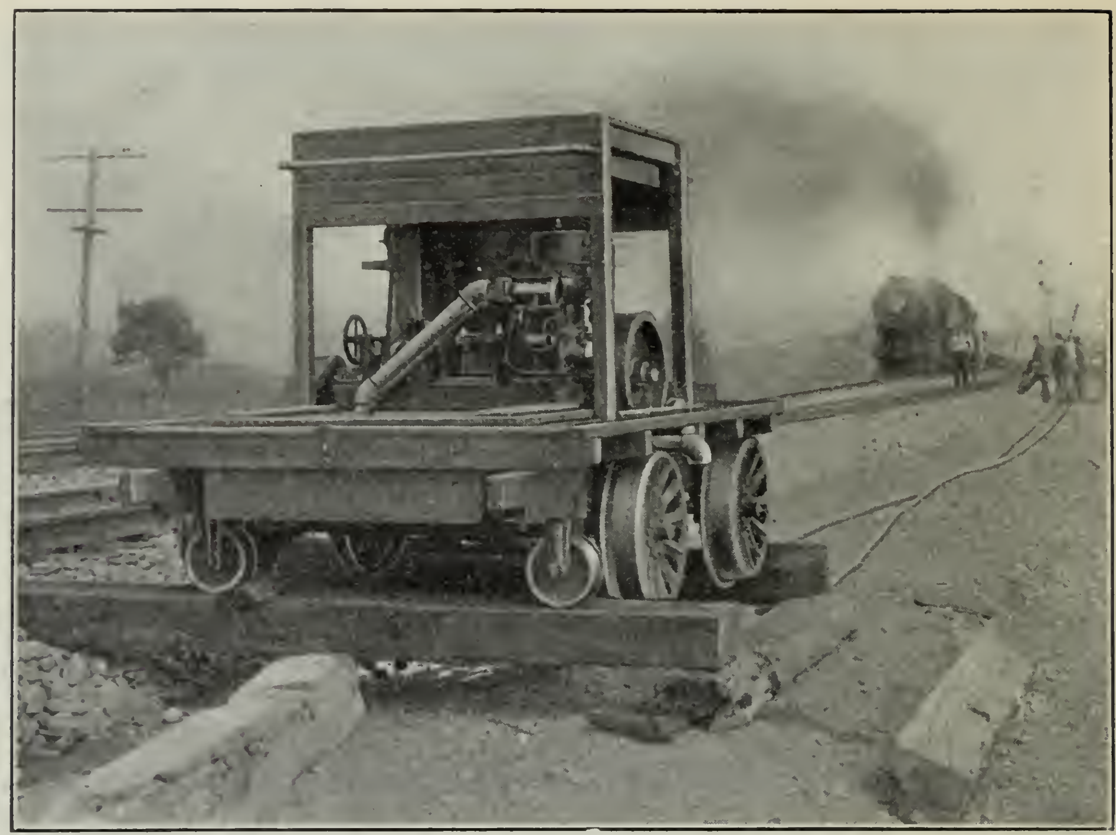


FIG. 3.

of track six months later showed the following results, the track settlement being noted in fractious of a foot:

	Greatest.	Least.	Av'g.
Hand tamping	0.116	0.018	0.067
Machine tamping	0.063	0.004	0.033

It was found that it is not absolutely necessary to clean the ballast out at the bottom of the tie, as must be done when tamping by hand, as the pneumatic tampers will work down through the ballast.

Further tests were made by the New York Central Railroad, employing one of the portable compressors and two tamping machines, and the impressions gained from the first test were fully confirmed. It was determined that the pneumatic tamper is thoroughly practical, that it does more uniform, more lasting and in every way better work than is possible to be done by hand, that good tamping can be done in contracted spaces, as in frogs, interlocking switches, cross-overs, etc., that it is unnecessary to remove tie and switch rods as the tampers work around them easily, that there is less injury to the ties from slivering and less crumbling of the ballast.

The New York Central purchased twelve of the complete portable compressor outfits, with tamping machines, hose, etc., and these were put into operation on several sub-divisions. A record was kept of the performance of each plant and the average accomplishment of the twelve is summarized as follows:

Hours per day	7.0
Ties tamped per day	177
Ties tamped per hour	26
Single track covered per day	316.8 ft.
Single track covered per hour	45.7 ft.
Gasoline used per hour	1.37 gals.
Gas Engine oil per hour	0.24 pt.
Compressor oil per hour	0.10 pt.

The work performed covered all classes: tamping track in face, tamping while lifting track from 1 to 6in., tamping cross-overs, etc. Two men are employed for the actual tamping while a third man forks up the stone and dresses the ballast. The latter also attends to the running of the compressor and interchanges with the others. It was found that three men thus employed will do more and better work than eight to ten with tamping picks or bars.

SHAFT SINKING WITH JACKHAMERS

BY LEROY A. PALMER.*

At the Black Oak mine in the "Soulsbyville granite" near the Mother Lode, jackhamers have replaced piston machines in shaft-sinking with a reduction of costs, air consumption, etc. Delay-action exploders have also been of assistance in sinking this shaft.

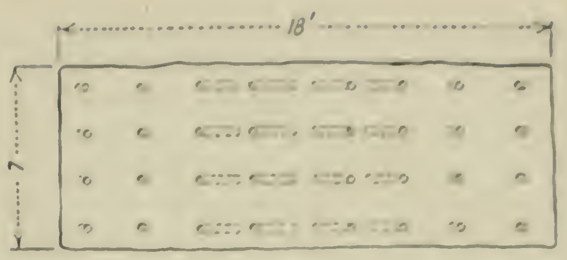
To the miner of the Mother Lode and the adjacent districts "Soulsbyville granite" conveys a meaning that cannot be amplified by a wordy description. This rock is a typical gray granite, shading into grano-diorite and containing intrusions of diorite. It is extremely hard.

The Black Oak mine is situated a mile from Soulsbyville in this granite area and is operated through a shaft which has just reached the 1900 level, work on sinking the sump being now in progress.

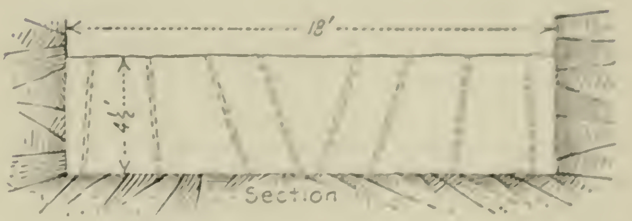
The shaft was carried to the 1600 level with piston machines; then it was decided to try jackhamers. Inasmuch as a careful comparison of the work of the piston machines in sinking from the 1500 to the 1600 with that of the jackhamers in sinking from the 1600 to the 1700 was in favor of the latter, the work was continued with the lighter machines. The piston drill was a standard type of 3-in. machine.

Four men were used on a shift in each case —in the one, on two piston machines, and in the other, each with a jackhamer—and it was found that the daily progress was increased approximately 25% by using the jackhamers. No attempt has been made to formulate a comparison of the air used but is is known that the four jackhamers consume less than the two piston machines.

The shaft consists of two compartments and a manway, being 7x18 ft. overall and 5x15 ft. in the clear. It is on a very steep incline which averages from 65 to 70 deg. An ideal round, drilled to break 4½ ft., is shown in the illustration. It consists of 32 holes, two sets of cut-holes, eight to a set, and two sets of side rounds of the same number. The procedure is to put in the inner cut-holes, blast them and muck out before drilling the rest of the round. The outer cut-holes and the side rounds are then put down and, if there is time, as is usually the case, another set of shallow cut-holes is drilled in the sump formed by shooting the first series of cuts. It has been found that this system of breaking the cut, then deepening the cut and shooting with the remainder of the round, has increased the progress of sinking about half a foot per round.



Plan



Section

Drilling and mucking of the inner cut-holes is all done on one shift by four men. The next two shifts are given over to the muckers who clean out the shaft and get it ready for the drillers. The mucking shifts consist of two muckers and an engineer for the donkey hoist on each shift.

Of course the placing of the holes is varied to suit conditions as they are found in the shaft and it sometimes happens that as many as 25 holes are put down for the side rounds but the illustration shows a typical round. In all of the holes 60 per cent. dynamite is used.

The present arrangement of doing all drilling on one shift and mucking on the other two has been very satisfactory. It calls for a total of 10 men including an engineer on each of the two mucking shifts to hoist the broken rock from the bottom of the shaft to the 1600, where it is user for filling. The same headway has been made thereby as previously when there were four miners on each shift, drilling or mucking as occasion required.

The men are paid on a bonus system. The regular wages are $3.75 per day to one of the miners who acts as shaft foreman, $3.50 to each of the other miners and the engineers, and $2.75 to the muckers. The miners each receive 25c. a day bonus for every month in which the shaft is sunk over 60 ft. and the muckers the same allowance for every day that they get the shaft cleaned out on time for the drillers to go to work.

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*Mining Engineer, 512 Custom House, San Francisco. Article reprinted, somewhat abridged, from Engineering and Mining Journal, Oct. 9.

During March, 1915, the shaft was sunk under the old arrangement of shifts, four miners on each shift drilling or mucking as the case might be. During this month the cost of sinking was $35.56 per ft. In April the shifts were rearranged, as noted, so that all drilling was done by miners on one shift and the shaft cleaned out by muckers on the following two shifts. For the first week under this arrangement of shifts the costs were brought down to $27.00 per ft. These are what the management refers to as "direct costs;" that is, cost directly chargeable to the shaft. They include timbering and hoisting from the 1900 to the 1600, but tramming on the 1600 is charged to stope filling. In view of the size of the shaft and the extremely hard rock in which it is sunk they can only be regarded as favorable.

Several records have been kept of the progress in drilling with these machines. All measurements were taken during the regular progress of shaft-sinking and with one man doing all of the work in connection with his machine; in other words no attempt was being made to establish a record. Measurements taken in a very hard rib of grano-diorite in the south end of the shaft showed a drilling speed of from 1.09 to 2.13 in. per min. on holes from 2½ to 5 ft. in depth and at all angles from flat to nearly vertical; an average for four holes was 1.64 in. per min. Allowing 32 holes to a round, which is to break 4½ ft., it will be seen that with four machines there is ample time for shooting the center cut, mucking out, drilling the side rounds and shallow cut-holes. In this connection it should be borne in mind that the actual percentage of drilling time is greater with a machine of this type than with a heavier machine.

Of course it is understood that the efficiency of the jackhamer is not due to superior drilling speed but to the ease with which it is handled. Careful records made at the Buckeye-Belmont mine at Tonopah showed that the actual drilling time in sinking the shaft with piston machines was only 160 min. per 8-hr. shift. The men wasted no time but they spent two-thirds of the shift in getting ready to drill and then in getting ready to shoot. A certain percentage of this loss, such as connecting ventilating pipe, changing steel, loading, etc., will be practically constant under any conditions. But it will be found that the greater portion of the loss is chargeable to setting up, tearing down and shifting the machine from one set-up to another. All of this loss is avoided with the jackhamer, which weighs only 40 lb.; and when the shift is ready to shoot, each man simply takes his machine into the bucket with him and the whole lot is hoisted away.

At the Black Oak shaft, ventilation is accomplished by an 8-in. Sturtevant fan on the 1600 level and compressed air at 85 to 95 lb. by an Ingersoll-Rand two-stage compressor, 11x9-16 in., belted to a 150-hp. motor. Considerable water is found in the upper levels but the shaft is dry.

The Black Oak has also used the jackhammers to some extent for drifting. They were mounted on the shell of an old machine on a vertical bar. Two of them, with one man to each, made better progress with less air than two men with one 3-in. piston machine. Detailed records of these trials were not kept.

DELAY ACTION EXPLODERS.

In connection with this shaft it is well to mention the use of delay-action exploders, to which the management is inclined to give much credit for the progress made, inasmuch as they have facilitated the firing of the shots. The "Ideal" delay-action exploder consists of a detonator, a time-fuse—whose length is chosen to suit the position of the hole—and an electric fuse-spitter to which is connected two copper wires. The detonator is placed in the cartridge in the usual manner and the copper wires attached to the fuses are connected in series, each end of the series being run to a wooden plug in a shallow hole at one end of the shaft. At these plugs connections are made with the two ends of an electriclight line brought down the shaft for this purpose. The exploder switch is in a locked box on the 1600 level, the key to the box being in the possession of the shaft foreman. There are no openings in the box for the wires leading

(*Concluded on Page* 7803).

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THE U. S. NAVAL CONSULTING BOARD

The U. S. Naval Consulting Board created by Secretary Daniels, eleven national engineering societies sharing with him the responsibility for its personnel, has wasted no time in getting ready for active work. Mr. Thomas A. Edison was appointed chairman of the board by Secretary Daniels, the other members, with the societies by which they were designated, are as follows:

American Institute of Electrical Engineers—
  Frank Julian Sprague and Benjamin G. Lamme.
American Institute of Mining Engineers—
  William L. Saunders and Benjamin B. Thayer.
American Society of Mechanical Engineers—
  William LeRoy Emmet and Spencer Miller.
American Society of Civil Engineers—
  Andrew M. Hunt and Alfred Craven.
American Chemical Society—
  W. R. Whitney and L. H. Baekeland.
American Electrochemical Society—
  Joseph W. Richards and Lawrence Addicks.
Inventors' Guild—
  Peter Cooper Hewitt and Thomas Robins.
American Society of Aeronautic Engineers—
  Henry A. W. Wood and Elmer A. Sperry.
American Society of Automobile Engineers—
  Howard F. Coffin and Andrew L. Riker.
American Aeronautical Society—
  Mathew B. Sellers and Hudson Maxim.
American Mathematical Society—
  Robert S. Woodward and Arthur G. Webster.

These men stand so high in their several professions that they accept no remuneration for serving their country in this capacity.

The first meeting of the board was held in Washington, October 6 and 7, and the following officers were elected:

Chairman—Thomas A. Edison.
First Vice-Chairman—Peter Cooper Hewitt.
Second Vice-Chairman—W. L. Saunders.
Secretary—Thomas Robins.

Mr. Saunders was the chairman at the sessions of the Board which were attended by members of the Board only, with the single addition of Mr. M. R. Hutchinson, who was present as Mr. Edison's "ear" and private assistant.

The first action of the board was to change the name from Naval Advisory Board to Naval Consulting Board, the change of title carrying with it the assurance that the members individually and collectively do not intend to force their advice unasked upon the Naval Board proper, but that they stand ready to place all their knowledge at the disposal of the Navy in consultation.

On October 6 President Wilson, at the White House, addressed the board as follows:

"There is very little that I can say to you, except to give you a very cordial welcome and to express my very great pleasure in this association of laymen with the Government. But I do want to say this:

"I think the whole nation is convinced that we ought to be prepared, not for war, but for defense, and very adequately prepared, and that the prepartion for defense is not merely a technical matter, that it is not a matter that the Army and Navy alone can take care of, but a matter in which we must have the cooperation of the best brains and knowledge of the country, outside the official service of the Government, as well as inside.

"For my part, I feel that it is only in the spirit of a true democracy that we get together to lend such voluntary aid, the sort of aid that comes from interest, from a knowledge of the varied circumstances that are involved in handling a nation.

"I want you to feel, those of you who are coming to the assistance of the professional officers of the Government, that we have a very serious purpose, that we have not asked you to associate yourself with us except for a very definite and practical purpose—to get you to give us your best independent thought as to how we ought to make ready for any duty that may fall upon the nation.

"I do not have to expound it to you; you know as well as I do the spirit of America. The spirit of America is one of peace, but one of independence. It is a spirit that is profoundly concerned with peace, because it can express itself best only in peace. It is the spirit of peace and good-will and of human freedom; but it is also the spirit of a nation that is self-conscious, that knows and loves its mission in the world and that knows that it must command the respect of the world.

"So it seems to me that we are not working as those who would change anything of America, but only as those who would safeguard everything in America. I know that you will enter into conference with the officers of the Navy in that spirit and with that feeling, and it makes me proud, gentlemen, that the busy men of America—the men who stand at the front of their professions—should be willing in this way to associate themselves voluntarily with the Government in the task in which it needs all sorts of expert and serious advice.

"Nothing ought to be done in this by any single group of persons; everything ought to be done by all of us, united together, and I welcome this association in the most serious and grateful spirit."

The first official recommendation of the board is for the creation of a Naval Research Laboratory, involving a first investment of $5,000,000, with annual operating expenses from $2,500,000 to $3,000,000, which means that the laboratory should be commensurate with the U. S. Navy of the future.

The Central Labor Union of Hudson County, N. J., is taking action upon the following resolution: "It is entirely consistent with trade unionism that the bodies of men who were loyal to the cause of union labor should be handled by none but union men." This is interpreted to mean that union men when they die will be laid out by union embalmers in union caskets, carried by union pallbearers to a hearse with union horses driven by a union driver, and buried in a grave dug by union grave-diggers or else cremeated by union cremators, and the obituary notice will bear the union label. Then the work of the union worms will begin.

Gas burners have been successfully used in recent experiments for the autogenic cutting of metal under water. According to the *Zeitschrift für Sauerstoff-und Stickstoffindustrie* the process is very simple. It is only necessary to screw over the point of the burner a bell-shaped hood into which compressed air is led during the cutting. The water is thus forced away from the mouth of the burner, so that the flame can burn freely. It is said that successful experiments with this new burner have been conducted at Kiel. Among others, a diver working at a depth of 5 meters cut through a square piece of iron with an edge 60 millimeters long in 30 seconds.

(*Concluded from Page* 7800).

down the shaft, so the door must be unlocked and opened before the wires are connected to their binding posts, and likewise they must be disconnected before the door can be closed. As a further precaution the switch is so arranged that the door cannot be closed unless the switch is open.

Thus the shaft men, after loading their holes and making the connections to the light line through the plugs, may leave the shaft leisurely. When the 1600 level is reached the shaft foreman goes to the switch box, opens it, connects the light-line wires to their binding posts and fires the round by closing the switch. Before he can close the door he must open the switch and disconnect the wires. Missed holes by this method are extremely rare; and it is certainly an improvement over spitting a round of holes with a candle or acetylene lamp, with the smoke so thick that one can hardly see, and then scrambling hurriedly into the bucket or up the ladder to reach a point of safety.

SCIENTIFIC HUMIDIFICATION

BY J. I. LYLE.*

So far as I am aware no mine has yet been humidified on a scientific basis or in fact in any manner that has been successful. Of those installations regarding which I have accurate knowledge, a few fundamental laws necessary for success have been neglected.

The temperature of a mine is fairly constant, varying with the seasons, so that in winter it is a few degrees cooler than in summer, with but slight fluctuations from day to day or even from week to week.

Generally a mine has sufficient humidity during the summer months, because its temperature is much below that of the outside atmosphere. In winter, however, when the outside air carries but little water vapor and the mine temperature is much higher, the relative humidity is necessarily low.

In order that the air used for ventilation may be able to carry sufficient water vapor to humidify the mine, it must be heated, either by its contact with the mine walls or artificially. The temperature to which it is heated must be at least that of the dew point desired.

Take a mine, for instance, with a temperature of, say, 60° F., where a humidity of 80 per cent. is desired with the outside air at 20° F. and containing 1 grain of vapor per cu. ft. Air at 60° F. and saturated carries 5.75 grains per cu. ft. With 80 per cent. humidity, therefore, each cubic foot would have to contain 80 per cent. of 5.75, or 4.6 grains. Now saturated air at 50° F. will just hold 4.6 grains per cu. ft. It is evident from this that it is necessary that the air should not be less than 54° F. when the additional water vapor is added. If at any lower temperature it could not possibly hold the required amount of vapor to give the 80 per cent. humidity.

It must be borne in mind that water cannot be evaporated unless heat is added; or to state it in another way, if water is caused to evaporate in the presence of air without heat being applied, the air will be cooled 8° F. for every grain of water evaporated per cubic foot.

This being true, if the air entering the mine at zero is raised to a temperature of 54°, the only way the necessary moisture can be added would be by blowing steam directly into it. It is well known that the introduction of steam directly into the air current without the production of fog is a most difficult matter, if it may ever be said to be successfully accomplished.

With the case under discussion, with the incoming air containing 1 grain of vapor per cu.ft. it would be necessary to add 3.6 grains per cu.ft., which if done without adding heat, as explained, would cool the air to approximately 28° F. To counteract this cooling effect we could heat the air to 82° F. and then bring it in contact with atomized water sprays and add the 3.6 grains per cu.ft., and as a result of the evaporation it would be cooled to 54°. At this temperature of 54° the air would be saturated, but as it traveled through the mine and its temperature was raised to 60° the humidity would be lowered to 80 per cent. such a system properly installed would give good results without any fog or other objectionable results. A simpler and more practical method is to first pass the air used for ventilating the mine through a humidifier, where its temperature is raised and the necessary amount of moisture is added simultaneously. Such a machine is now being adopted in textile mills for cooling and humidifying the air.

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*Treasurer, Carrier Engineering Corp., 39 Cortlandt, street, New York City.

Here the air passes through a dense and finely divided water spray, where it is saturated. The water used is circulated by means of a centrifugal pump and is heated by the introduction of exhaust steam. Eliminator plates at the outlets are used to separate the surplus water from the air, so that the air is left perfectly free of any fog or other small particles of water that have not been evaporated. Because of the recirculation of the spray water employed by this machine, the amount of water required is small and is equal to that evaporated. This would never exceed 1 gal. for each 12,000 cu.ft. of air used.

The exhaust steam required to heat the spray water (which in turn would heat the air to 54° F.) would be 1½ lb. per 1000 cu.ft. of air handled. Of course, with a large ventilating fan this amounts to considerable steam, but in most mines there is sufficient exhaust going to waste to fulfill the requirements.

To summarize: First, it is necssary that the moisture for mine humidification be injected into the air after its temperature has been raised to approximately that of the mine. secondly, this moisture must be added in such a manner as not to cool the air below the temperature required to carry the desired vapor. Thirdly, the injection of steam into the air at or near the entrance of the mine is sure to produce fog and cannot add the amount of vapor required owing to the temperature of the air being too low to carry it. Fourthly, the humidity of a mine can be maintained uniformly at a desired point by a properly designed humidifier, with heated spray water, located at the air entrance to the mine. *Coal Age.*

CO-OPERATION AND INTERDEPENDENCE OF THE CIVIL AND MECHANICAL ENGINEER

BY GEO. W. DICKIE.

[The following is an extract from an address by Mr. Dickie as Vice-President of the American Society of Mechanical Engineers in response to an address of welcome to the Society by Mr. C. C. Moore, President of the San Francisco Exposition.]

It is very fitting, sir, that you should bid us welcome at this time, as we are here like many others to help celebrate the greatest engineering achievemnt of our time, the cutting in two of the Western Hemisphere, joining the two great oceans of the world, forming a new pathway for the world's commerce. Our great Exposition that celebrates the completion of this great work, has developed into a thing of wondrous beauty, with you, sir, as its guiding head. It is true that another engineering society will naturally claim first honors in the great work that we celebrate, yet it must never be forgotten that the civil engineer can not go very far in any work he undertakes without the active help of the mechanical engineer. If he wants to dig either a big or a little ditch, and needs a shovel for the purpose, either an ordinary 25 lb. hand shovel or a fifteen ton steam shovel, he must get the mechanical engineer with him before he can do any digging, and at this time it is worth while remembering that nearly all the great work carried out under the civil engineer is necessary, because of what the mechanical engineer has been doing. The great steamships that originate with the mechanical engineer, made the Panama Canal a necessity. The locomotive engine, with its long line of cars, makes necessary the tunnels and bridges that the civil engineer constructs for their passage. In fact, nearly all great modern works of which the civil engineer is so justly proud, have been produced in order that the work of the mechanical engineer may either run over or through them. The work of the civil engineer is more spectacular and more in the public eye, thus exciting admiration that is reflected on the designer and builder.

Sailing on one of the Hudson River day steamers, up that splendid river about two years ago, I saw ahead an airy structure spanning the river at a great height, looking like a huge spider web, too attenuated in appearance to serve any practical purpose, but as the boat came nearer, the stability of this structure became more apparent, and admiration of the boldness of it began to take possession of my mind, then something appeared at one end of this airy structure, and quickly took possession of it as a pathway to the other side. Here was the explanation of it all. The mechanical engineer needed the Poughkeepsie Bridge for his locomotive and train to cross the river, and he also needed the river for his steamer, and so we find as we contemplate the work of these great branches of engineering, that they are "Useless each without the other." The one is static, that is engineering in repose, the other dynamic—engineering in motion, and they are every day becoming more important factors in the work of the world. Even war has now become largely a job for the mechanical engineer, and seeing that we can neither live comfortably, nor die bravely without the help of the mechanical engineer, his position among the useful elements of society should be improved, so that he would occupy a place in the estimation of his fellow men commensurate with the indispensable character of the service he renders to the world. I would not seek a higher place for the mechanical engineer than that which is freely granted the civil engineer, but it should not be lower, and it is one of the functions of the Society that I represent here to-day, to help the mechanical engineer find his true place among the professional men of his time.

To the 6,000 members of this Society, the country is largely indebted for the position she occupies among the nations of the earth. That she is able to furnish other nations with so many implements through which progress is made, is largely due to the work accomplished by members of this Society. That the reward that comes to them financially is not what it ought to be is shown by the small percentage of our members who have been able to cross the continent, and see the wonderful dream that has become a fact, sir, under your direction—and attend the meetings to be held here. This is to be regretted, but cannot be helped. Engineers as a rule do not acquire wealth, and perhaps it is just as well for them that they don't—there would be less good work done if it were better paid for. The best work that has ever been done for this old, ungrateful world of ours, was never paid for. You can't do the things that you think ought to be done, if you wait for a contract insuring pay before you do them. Many noble engineers still do the things they love to do without any thought of pay, and so long as that is the case, we can well be proud of our profession. The present President of this Society is a splendid example of the character of man I refer to. It has often been said of the family I belong to, that they would rather build ships and starve, than do anything else and become rich, and I trust they will continue in that frame of mind.

DEOLEIZER

This is a word which has not yet found its place in the dictionary. It represents an apparatus for removing oil from condensed steam or from any water in which oil is emulsified. It is in a class by itself entirely removed from the so-called oil separators. It takes out all the oil (which no mechanical straining or filtering can do) so that the water will even be drinkable or, without any other treatment, can be used directly for the manufacture of ice.

Advantage is taken of the phenomenal affinity for oil of a novel composite material, which has been named oleite. This is not an invention but a discovery. It is of a mineral character and resembles granulated charcoal or old-fashioned black gunpowder, but is very different from either. A mass of this material is suspended in a wire basket within the deoleizer and the pipes are constructed so that the water will flow through. An ordinary filter charged with, say, sand, charcoal or boneblack, is dependent for its capacity and efficiency almost entirely upon its surface area, which is not the case with oleite. The voids are large in it, the oily water penetrates all through the mass, and the deposition of oil is substantially as effective within the body of the material as on the surface. When the oleite is approximately saturated or clogged with oil it can be renewed over and over again by dumping into a steel tray and heating to redness over a furnace fire, this merely burning out all the oil.

The deoleizer is being installed entirely upon specific guarantees of performance, and it already has a great record of savings, especially in connection with the boiler feeds of large plants. A very convincing circular and full information on the deoleizer is supplied by Williams Andrews, Inc., 120 Liberty St., N. Y. City.

NOTES

Uniformity of burning speed is a desirable quality, but fuse that burns in the open air with a maximum variation of 10 per cent. up or down from standard, is within reasonable limits. The generally accepted speed is 90-

seconds per yard, or 25 minutes per 50 ft. This is fast enough to preserve a fair degree of regularity, and slow enough to produce quiet burning.

Heat increases the speed of hardening concrete. Setting by steam has been successfully employed in constructing the 27-mile concrete pipe line from Sooke Harbor to Vancouver B. C. The pipe is constructed in sections, each section being immersed in live steam for 24 hours, the steam causing the concrete to set as well as would otherwise be obtained by a month's exposure to the air at ordinary temperatures.

The Minnesota ranges are still producing more iron ore than is produced in the rest of the States together, having furnished 52.96 per cent of the total for the United States in 1914, as compared with 62.37 per cent in 1913. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 33,540,403 tons in 1914, or 80.94 per cent of 'the total production.

Attention is called to the fact that when using the oxy-actylene flame for welding the temperature is so great as to cause the vaporization of some metals; and as the operator has to hold his head quite close to the work he must necessarily inhale some of these metallic fumes, with possible injury to his health. It is suggested that, as the operator must wear colored goggles in any case to protect his eyes from the intense light, it might be well to combine these in a helmet that would protect his lungs.

Anyone can understand the application of good sense, good will and system in mills and factories, but no American can approve any plan that lessens the responsibility of the individual by turning him into a machine. That is not real progress, even though it may enable some shop to get out a few more bolts at a reduced price. The word "efficiency" has thus been overworked. It bids fair to become so offensive as to drive us into a reaction against all activity that concerns itself with materials, unless the soul goes with it. —*Ira N. Hollis.*

Many American railroads are obliged to use heavy envelopes of large size for transmitting papers from one department to another, and this entails considerable expense. As it is not usually necessary to seal these envelopes, and they are, therefore, not subject to mutilation, it has been found possible to use these envelopes a number of times; and to facilitate the process, and to insure the economy, lines are printed on the face of the envelope for a dozen addresses, each being crossed off after it has served its purpose.

A "smoke tintometer" has been devised to be used in determining at any time or place the degree of smokiness of the atmosphere. It consists of a tube with a single eye-piece and two object openings. One of these openings is clear while in front of the other is a rotatable diaphragm in which are set five discs of glass, one clear and the others with various tints corresponding with the standard tints of a "smoke-chart." In judging smoky air the diaphragm is turned until the tinted glass approximately coincides in darkness with the air seen through the clear aperture.

As soon as the war comes to a close on the other side of the water there is going to be a shortage of cutters and carvers in this country. It is time for the wise business men to provide the labor saving equipment of pneumatic tools and every other labor saving device, so as to be in a position to maintan the business short handed, for such a condition is sure to arise.—*American Stone Trade.*

Citizens of the new town of Anchorage, the Cook's inlet headquarters for the Alaska Engineering Commission, have begun preparations to create a model village, following the completion of the government's first sale of town lots. Out of 1,178 lots offered, 635 were sold for a total of $147,235. Anchorage is to be made a model town in every respect. J. A. Moore, manager of the town, for the government, is mayor. He has issued strict rules regarding building and sanitation.

Charles A. Fritz, who during the summer and fall of 1914 was engineer in charge of the construction of a sewer outfall at Manchester, Mass., describes the using on the work of a pneumatic hammer under water. The outfall extended two miles into tidal waters ranging in depth below mean low water from zero to 40 ft. At a depth of about 16 ft. two small ledges were encountered in the trench. The contractor (the T. A. Scott Co., New London, Conn.) had a timber crib, which was to be used to support a steam drill on a tripod. Mr. Fritz suggested the use of a "Jackhamer" pnuematic-hammer drill, which was successfully tried. The only drawback to this use of the drill was that the exhaust annoyed the divers, but this was easily remedied by bringing the exhaust to the surface by the use of a common garden hose.

Quebec, Aug. 20.—While two young boys named Pichette, brothers, aged 14 and 8, were playing in the C. P. R. shops this evening the elder placed an air compressor hose against the younger's body and called to an engineer who was playing with them in the next room to turn on the air. Ignorant of what was going on the engineer did so, the result being that the boy's body was blown open, and he died a short time afterwards.

[It is of course understood that in this case, as in some similar horrible cases which are matters of record, the air nozzle was not placed *against* the boy's body.—Ed. C. A. M.]

A weather Bureau Station has just been established on a farm near Omaho, Neb., for the purpose of making systematic observations of the upper air, by means of kites carrying self-recording instruments. It was not necessary to erect new buildings, excepting a small shelter for the kite reel, as the buildings on the farm were sufficient for the needs of the work. This work was formerly carried on at Mount Weather, Va., and the apparatus was moved from that station to the present one. This station will be known as the Drexel Aërological Station, and the observations obtained here will be sent to the Central Office of the Weather Bureau at Washington, D. C., for computation and study. Kite flights were begun at this station Sept. 1.

Sulphur and yellow fever are not usually thought of together, but it was the employment of 300 tons of sulphur and 120 tons of insect powder, the entire supply of the United States, that enabled Gen. Gorgas to destroy the mosquitos in Panama and so thoroughly eradicate yellow fever that no case has occurred since May, 1906. Before the use of sulphur and other sanitary measures the annual death-rate from yellow fever expected, on the basis of the French ratio, was 3,500. The death-rate during the French occupation was 200 per 1,000. In ten years of the American control the rate was 17 per thousand.

Probably more copper has been destroyed, as we say it, or has gone beyond human pen, in this one year of war than was previously destroyed in all of the world's history. Copper as used for the manufacture of ordinary articles is not destroyed and is ultimately available for other uses, but copper used in ammunition is absolutely lost.

Nickel has become one of the precious metals in Europe. It is said that the Germans have been gathering all the nickel coins available in Belgium and in Germany for use in the manufacture of war materials. As a result, the Federal Council of the German empire is reported to have passed a bill to coin 5 pfennig pieces in zinc instead of in nickel as heretofore.

The Weather Bureau has undertaken a campaign for the determination of the relative values of evaporation in various parts of the United States, and, if possible, the relation of these values to other climatic factors. The Bureau is also preparing to publish the results of its previous elaborate observations of evaporation at Salton Sea and elsewhere.

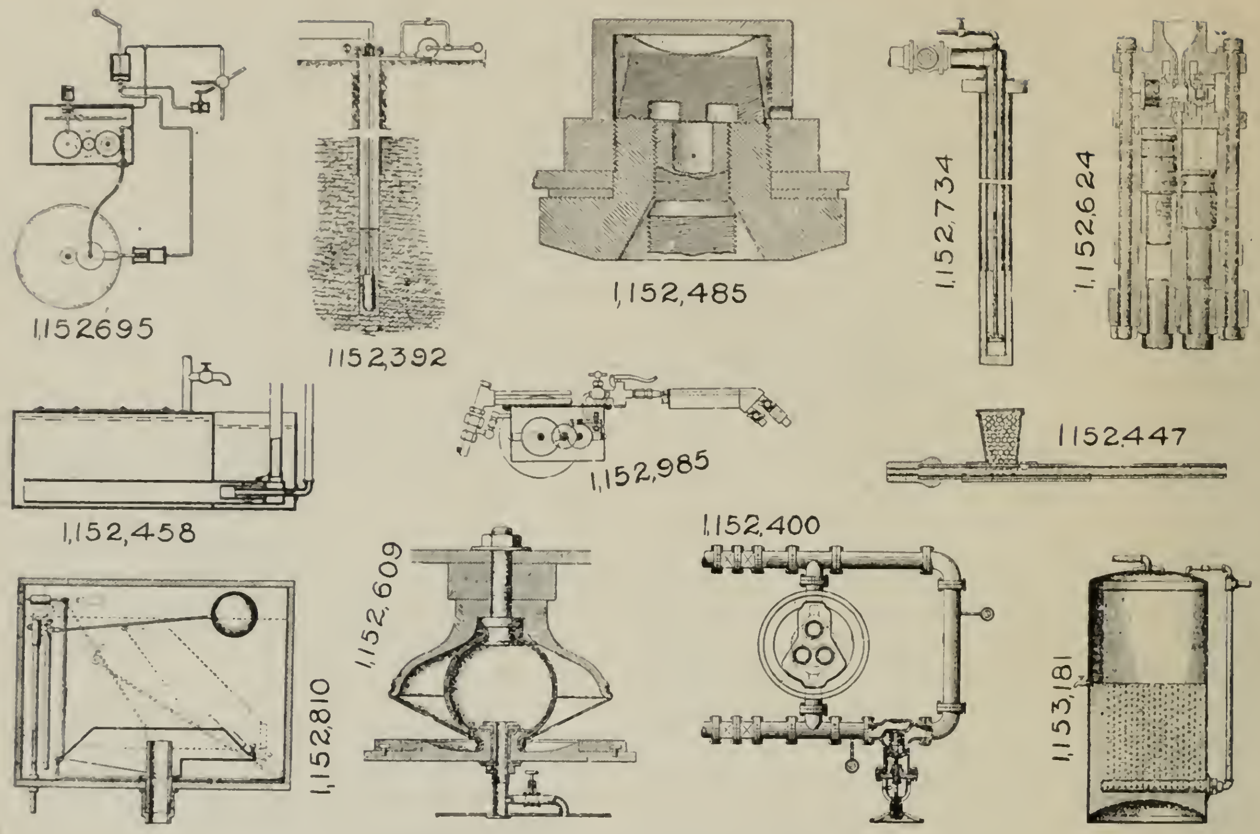
LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 7.

1,152,392. METHOD OF TREATING SUBTERRANEAN WELLS. EDWARD NICKLAS BREITUNG, Marquette, Mich., and ALFRED PICK, New York, N. Y.

2. The method of treating subterranean wells which consists of heating the material in the well, applying a continued artificial pressure to the material greater than the natural pressure thereon for a substantial period of time to thereby force said heated material into the openings of the



Pneumatic Patents September 7.

surrounding medium and in then releasing the artificial pressure to allow the material to again enter the well.

1,152,400. MEANS FOR CONTROLLING THE OPERATION OF AIR AND GAS COMPRESSORS. James H. Dennedy, Detroit, Mich.

1,152,414. WET DUST-COLLECTOR. George A. Helson, Peterborough, Ontario, Canada.

1. In a dust collector the combination of a blower provided with a suction inlet; means for introducing water into the blower; a discharge pipe for the blower; a water tank into which the discharge pipe leads; and baffles in said discharge pipe close to the blower and inclined alternately in opposite directions whereby the water is beaten into fine spray and intimately mixed with the dust-laden air passing through the apparatus.

1,152,447. AIR-GUN. William J. Sproull, Saginaw, Mich.

1,152,449. AIR CAN-TESTING MACHINE. Edwin V. Swangren and Magnus E. Widell, Maywood, Ill.

1,152,458. APPARATUS FOR BLEACHING CANE-JUICE. William H. Waggoner, Jeanerette, La.

1,152,473. VACUUM-CREATOR. Edward M. Barnes, Hastings, Mich.

1,152,485. DISCHARGE CONTROL FOR FLUID-RECEPTACLES. John E. Carroll and William H. Andrews, Boston, Mass.

1,152,609. PNEUMATIC SPRING. Benjamin Walter Davis, Phillips, Wis.

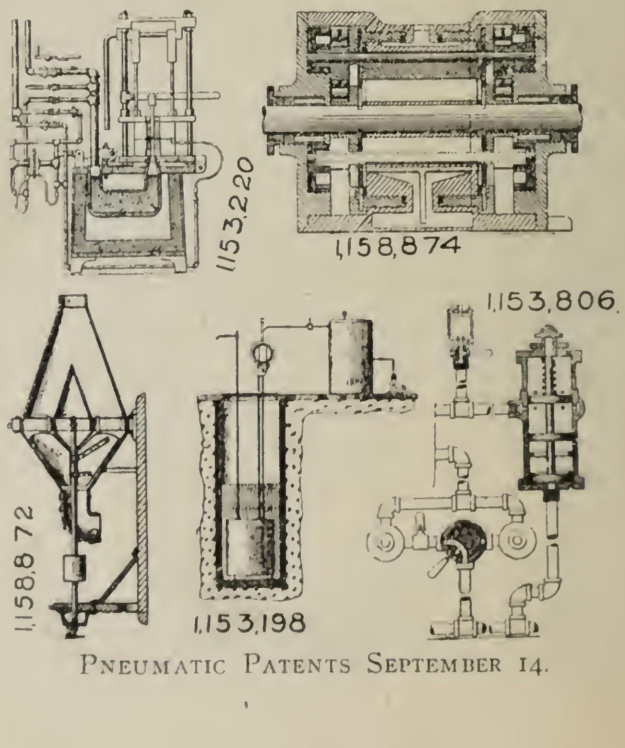
1. A pneumatic spring comprising a substantially globular fluid retaining chamber having flexible walls, curved means engaging the flexible walls of the retaining chamber to increase the supporting area thereof at a predetermined rate when weight is applied thereto, and means for connecting said chamber to two relatively movable members between which the chamber is interposed.

1,152,624. PNEUMATIC TOOL. George H. Gilman, Claremont, N. H.

1,152,695. BRAKE-ACTUATING DEVICE FOR AUTOMATIC TRAIN-STOP MECHANISM. Fred Bedford, Stratton, Nebr.

1,152,734. PUMP. Joseph F. Jones, Jr., Bakersfield, Cal.

In a compressed air lift pump, the combination with an outer circular flow pipe, of an air pipe concentrically positioned therein and extending to a point adjacent the lower end thereof to provide an annular space between said flow pipe and said air pipe, a T-shaped casing secured on the lower end of said air pipe and having its opposite



Pneumatic Patents September 14.

ends closed, a discharge nozzle projecting at substantially right angles from said casing on diametrically opposite sides of said air pipe substantially midway of said annular space, said nozzle being inclined to the vertical and discharging upwardly to produce a spiral motion around said air pipe, the construction and arrangement of parts being such that air bubbles move inwardly toward the air pipe and decrease the friction between the surface thereof and the body of ascending water.

1,152,810-1. PNEUMATIC VALVE APPARATUS. GEORGE A. HANLY, Elgin, Ill.

1,152,882. DEVICE FOR ROTATING PNEUMATIC DRILLS. HENRY J. COOK, Los Angeles, Cal., and HERBERT E. MARSDEN, Ottumwa, Iowa.

1,152,985. ACETYLENE-BLOWPIPE. JOHN W. SMITH and ELMER H. SMITH, Minneapolis, Minn.

1,153,026. TIRE-PRESSURE GAGE. ROBERT A. CAMPBELL, Minneapolis, Minn.

1,153,181. AIR-DRIER. GEORGE F. STEEDMAN, St. Louis, Mo.

SEPTEMBER 14.

1,153,198. APPARATUS FOR RAISING WATER. WILLIAM T. CROSLEN, Oklahoma, Okla.

1,153,220. CASTING-MACHINE. CHARLES M. GREY, East Orange, N. J.

1. In a casting machine, the combination of two chambers having communication below the surface of material adapted to be contained therein, means for exhausting air from both of said chambers, whereby a partial vacuum is produced above the material therein and the metal freed from entrained gases, and means whereby one of said chambers may be exhausted independently of the other.

1,153,554. PNEUMATIC PIANO-PLAYER ACTION. WALTER A. KRUCK, New York, N. Y.

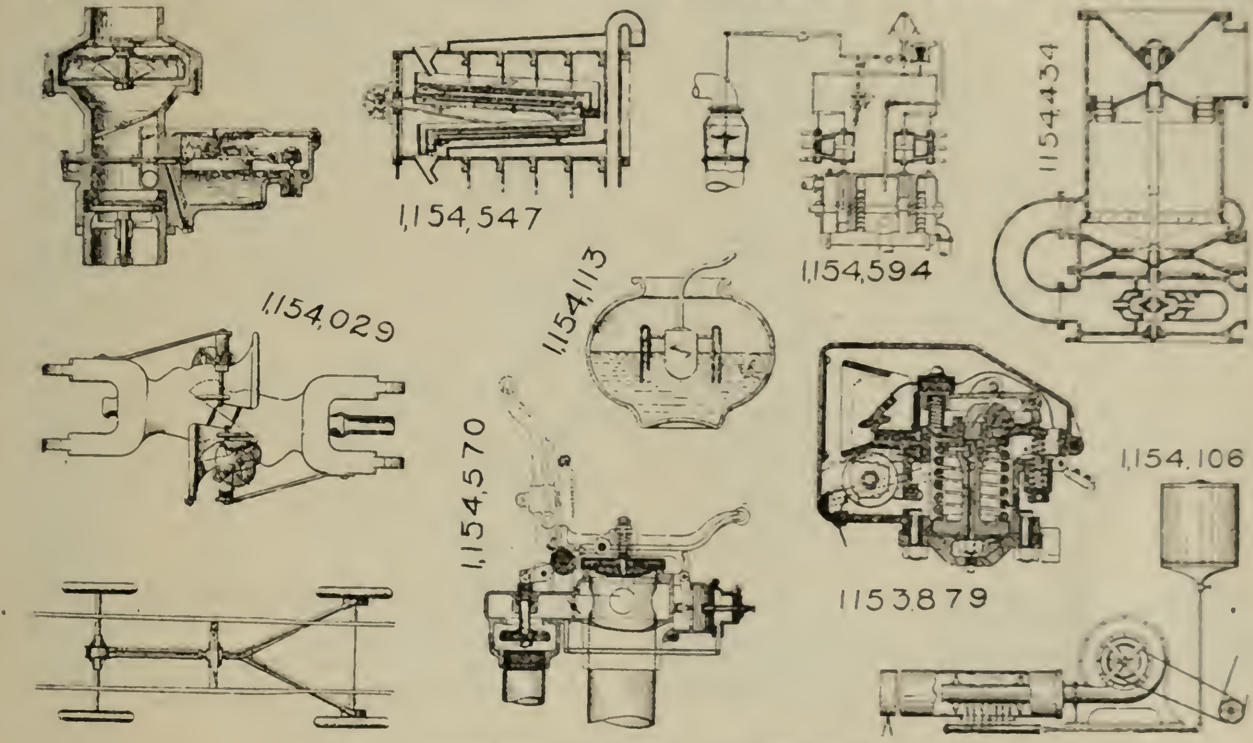
1,153,734. VACUUM CLEANING APPARATUS. WALTER G. TRAUTMAN, Cleveland, Ohio.

1,153,759. FLUID - PRESSURE-CONTROLLING VALVE. JOSEPH BRUNKER and CHARLEY ALBERT MATTMILLER, Helena, Mont.

1,153,806. AIR-BRAKE DEVICE. ERNEST U. MACK, Florence, S. C.

1,153,872. VENTILATOR-FAN. DAVID W. MATSLER, Kingston, Okla.

1,153,874. ROTARY COMPRESSOR. WILLIAM SHORE, Toronto, Ontario, Canada.



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SEPTEMBER 21.

1,153,879. PNEUMATIC GOVERNOR. BURTON S. AIKMAN, Chicago, Ill.

1,153,913-4-5. MIXING DEVICE. FORREST A. HEATH, Jersey City, N. J.

1,153,930. FLUID-POWER TRANSMISSION. ARCHIBALD T. KEENE, Chicago, Ill.

1,154,028. TRAIN-PIPE COUPLING. HOWARD S. KIMMEL, Tiffin, Ohio.

1,154,029. FLUID-PRESSURE COUPLING-HEAD. HOWARD S. KIMMEL, Tiffin, Ohio.

1,154,106. AIR-BLAST-HEATING APPARATUS. FERDINAND EPHRAIM, San Francisco, Cal.

1,154,113. HUMIDIFIER. WILLIAM S. HADAWAY Jr., New Rochelle, N. Y.

1,154,306. VACUUM-INDICATOR. GEORGE F. GRAY, Schenectady, N. Y.

1,154,434. ROTARY CONDENSER AND SELF-CONDENSING TURBINE. EDMUND SCOTT GUSTAVE REES, Stafford, England.

1. An ejector condenser, air pump or compressor, comprising an entraining chamber connected with the space to be evacuated, an ejector wheel, spraying nozzles connected with a supply of liquid under pressure and adapted to direct sprayed liquid across the entraining chamber into the rim of the ejector wheel, and a stationary expanding duct to which the ejector wheel delivers.

1,154,547. PROCESS OF PURIFYING FLOUR DURING THE MANUFACTURE THEREOF. GEORGE THOMAS SMITH, Fort Worth, Tex.

1. The herein-described process of purifying flour containing impurities lighter in weight than flour, which consists in moving said flour and impurities in a relatively thin layer and simultaneously forcing a slight draft of air uniformly throughout said moving layer for lifting and carrying away said lighter impurities from said flour.

1,154,570. PNEUMATIC - DESPATCH - TUBE APPARATUS. CHARLES P. HIDDEN, Winchester, Mass.

1,154,594. REGULATING DEVICE FOR MIXED-PRESSURE TURBO - COMPRESSORS. RICHARD H. RICE, Lynn, Mass.

SEPTEMBER 28.

1,154,609. METHOD OF INCREASING THE ENERGY OF A FLUID-MOTOR IN MOTOR-DRIVEN TORPEDOES. MICHEL BRUNIQUEL, Paris, France.

1. The process of increasing the energy supplied to a motor driven by compressed fluid which consists in subjecting such fluid while on its way to the motor, to the heat of a suitable fuel in combustion while injecting hydrogen peroxid into the sphere of combustion.

1,154,648. FLUID-PRESSURE TURBINE. Carl J. Mellin, Schenectady, N. Y.

1,154,672. WHISTLE. Richard Tikijian, Waterbury, Conn.

1,154,707. SPRAYING DEVICE AND MEANS FOR CONTROLLING THE SAME. Daniel M. Luehrs, Toledo, Ohio.

1,154,745. METHOD OF AND APPARATUS FOR ELEVATING FLUIDS BY ELASTIC-FLUID PRESSURE. Ralph C. Browne, Salem, Mass.

1. The method of raising fluids by elastic fluid pressure to a height greater than that of a continuous column of the fluid operated on sufficiently high to balance such pressure, which consists in flowing a working fluid through a loop, simultaneously causing the heavier fluid to collect in said loop until the passage there through for the working fluid is closed, and immediately displacing the collected fluid by pressure of the working fluid applied downwardly on the upper surface thereof, thereby forming a composite column made up of alternate masses of the fluid operated on and the lighter working fluid.

1,154,793-4-5-6. COMPRESSED-AIR SYSTEM FOR OPERATING PNEUMATIC TOOLS. Charles Otis Palmer, Cleveland, Ohio.

1,154,797. PNEUMATIC TOOL. Charles Otis Palmer, Cleveland, Ohio.

1,154,798. GOVERNOR FOR AIR-COMPRESSORS. Charles Otis Palmer, Cleveland, Ohio.

1,154,880. POWER-GENERATING SYSTEM. John Patten, Baltimore, Md.

1. The method of employing carbon dioxid, as a medium for converting heat into work, which consists in successively compressing the carbon dioxid, heating it, expanding it in an engine, and cooling it, and wherein the lowest pressure during these operations is not substantially less than critical pressure.

1,154,894-5. GLASS-FORMING MACHINE. William S. Teeple, Wellsburg, W. Va.

1,154,921. PERCUSSIVE DRILL. Charles C. Hansen, Easton, Pa.

1,154,922. COAL-MINING MACHINE. Charles C. Hansen, Easton, Pa.

1,154,957. PNEUMATIC MUSICAL INSTRUMENT. Harry J. Anderson, Chicago, Ill.

1,154,959. REGULATING MEANS FOR CENTRIFUGAL COMPRESSORS. Otto Banner, Easton, Pa.

1,154,974. WELDING-TORCH. Burr Custer, Marion, Ind.

1,154,977. PULSATORY TOOL. Clarence A. Dawley, Plainfield, N. J.

1,155,045. APPARATUS FOR PRODUCING OXYGEN. Benjamin H. Cram, Baltimore, Md.

1. In an apparatus for making oxygen by decomposition and regeneration of an oxygen compound, a retort for the oxygen compound, means for heating the retort, means for passing heated air and superheated steam alternately through the retort, valves for alternating the path of the air and steam and automatic means for operating the valves, equalizing the period and maintaining the sequence of operation.

1,155,074. AIR-OPERATED FIGURE. Lewis A. Mapel, St. Louis, Mo.

1,155,177. FLUE-BLOWER. George H. Van Schaick, Hudson Falls, and Patrick Burns and John Reardon, Fort Edward, N. Y.

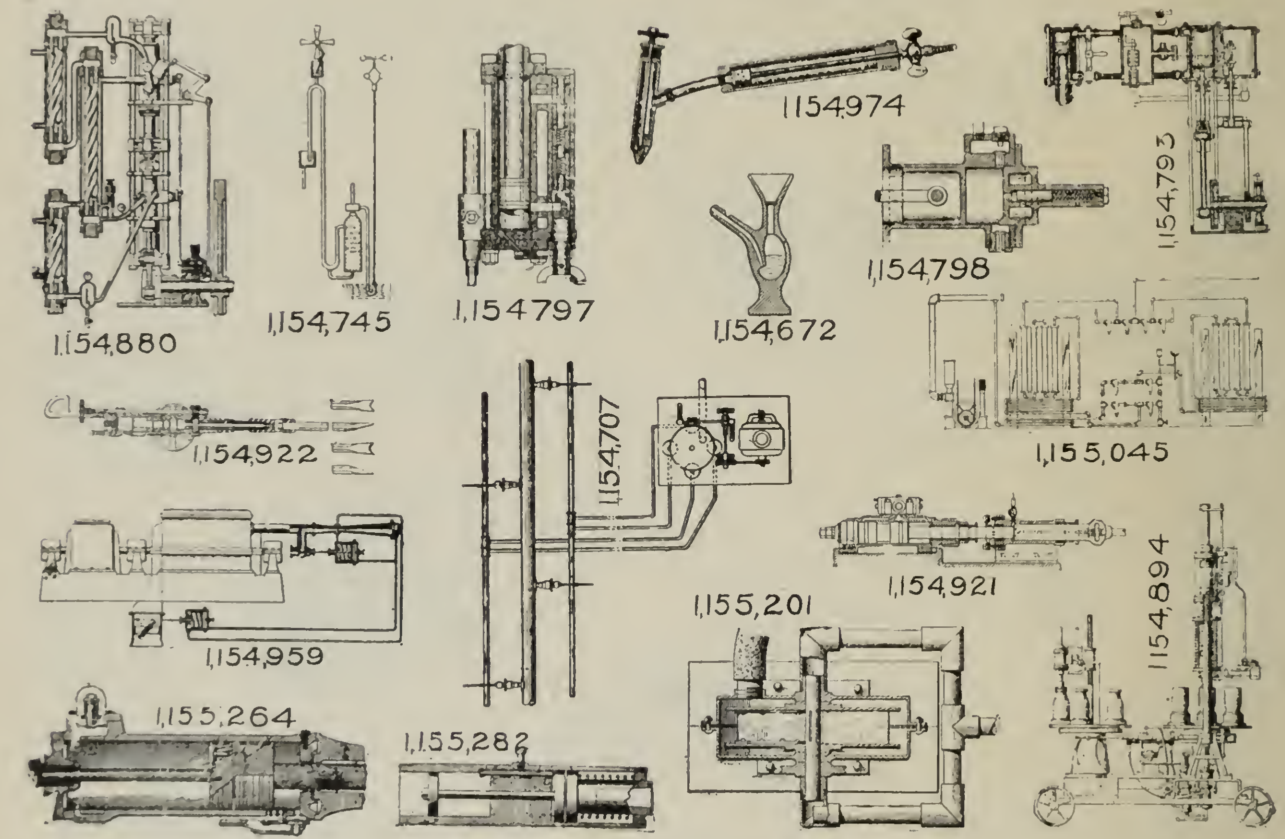
1,155,201. VACUUM-CREATOR. Charles H. Best, Morland, Kans.

1,155,264. PRESSURE DEVELOPING AND DRIVEN TOOL. Alexander Palmros, Syracuse, N. Y.

1,155,272. DUST-COLLECTOR FOR PNEUMATIC STREET-SWEEPING MACHINES. John R. Pollock, Long Beach, Cal.

1,155,282. PNEUMATIC HAMMER. Maconius Shaner, Bethlehem, Pa.

1,155,308. PROCESS OF CONDITIONING AIR. Daniel P. Gosline, Boston, Mass.



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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XX DECEMBER, 1915 No. 12

THE FUNCTION OF A NAVAL EXPERIMENTAL LABORATORY*

The recommendation of the Naval Consulting Board that a physical laboratory be established on tide water for the conducting of experiments by the Government seems to have been misunderstood. It is not true that it is proposed that such a laboratory should be under the direction of the civilian board. On the contrary it is to be controlled and directed by the United States Naval officers.

It is not true that the civilian board, or any other board of inventors, is expected to go within the walls of this experimental station and invent or produce devices for the use of the navy. The proposition is that this shall be a great physical workshop for the purpose of trying out and developing inventions which will have been submitted from all sources to the United States Government.

When such inventions are submitted and are first passed upon by the regular naval engineers, it is proposed to submit them, or some of them, to the civilian consulting board for advice and information, and when such advice is received by the naval engineers, and they elect to go further into the suggestions made, then the physical laboratory will be a means by which it may be determined whether or not an invention is a practical one.

The Naval Consulting Board is, as its name implies, a board of consulting engineers and not necessarily a board of inventors. They are not expected to originate plans or practices to any greater extent than all the people of the United States are expected to do so. Their position is identical with that of any other individual in the United States who may have a suggestion to put before the Government, the difference being that in the case of the Consulting Board they may be called upon by the naval engineers to express their opinions, to give advice, and perhaps personal assistance, in the development of ideas.

The members of the Naval Consulting Board are responsible to no one except to the societies which elected them. They are in no way Government employees or officers. They receive no compensation from any source, and they pay their own expenses.

The United States Government has now two large and many smaller experimental stations. The principal one is the Bureau of Standards at Washington, under the Department of Commerce, where a great deal of scientific work is being done in the nature of research and investigation. There is also the Bureau of Mines, where research and experimental work is conducted in metallurgy and chemistry. At various navy yards in the country there are experimental stations, but at no place is there a plant at tide water where actual physical work may be done in the way of building machines on a large scale for the purpose of demonstrating to the satisfaction of the United States naval officers whether or not an advance may be made in naval practice. Such a station could be no small affair, for to be of real value it should be so equipped as to reach results expeditiously and thoroughly. In other words, it should do for the Government what Edison's laboratory has done for science and what the

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*From an article in *The Engineering Magazine,* November, 1915, by W. L. Saunders, Vice Chairman of the Naval Consulting Board, and President of the American Institute of Mining Engineers.

General Electric Laboratory has done for that company.

Experimental or development work is necessarily expensive, but our experience in the past would seem to warrant us in believing that it is better to spend money in trying out and perfecting devices for naval service rather than to depend upon the natural course of events during which developments take place slowly through other sources, and in the end individuals or other nations get the benefits that might accrue to this Government. We have only to cite two recent cases of importance—the submarine and the aeroplane—to realize that the American navy would have been far more advanced had the Government taken up through its own physical station the early inventions of Holland and the Wrights. It is work of this kind that can best be done through a large and well equipped physical laboratory under the control of the Government. The man who has had more experience in this line than any other and has achieved a greater success is undoubtedly Mr. Edison. The proposed plan for this research station is his. His greatest work has been acquired through research and experiment. Before he invented the storage battery he tried more than ten thousand experiments, always aiming at a certain result, which he finally achieved. The General Electric Company have found it of the utmost value to spend hundreds of thousands of dollars in research work. It has paid to do it, and why should we hesitate to follow the same lines in protecting and strengthening the greatest and richest of nations? The proposed physical research laboratory, even at the maximum figures placed by Mr. Edison—five million dollars, represents only about one-third the cost of a large battleship. Is it not best to first make sure that we are building this ship right, and in advance of the practice of other nations, rather than plunge forward at large expense and in the end discover costly mistakes? America has long been the birth place of the greatest inventions. Let us utilize this creative force in increasing the safety, strength and efficiency of the nation.

The visible smoke and steam that come out of a plant may indicate industry, but at the same time they indicate inefficiency and wastefulness.

SINKING OF THE WOODBURY SHAFT AT THE NEWPORT MINE, IRONWOOD, MICH.*

The Woodbury shaft, which is now being sunk by the Newport Mining Company at Ironwood, Michigan, is a vertical shaft at right angles to the strike of the formation. The over all dimensions are 21 ft. 1 in. by 13 ft. 1 in. with six compartments which will accommodate two skips, two cages, one ladder road and necessary piping. The first 100 ft. of sinking was in quartzite; from 100 ft. to 715 ft. were alternating strata of gray and red slates and quartzite. Below this is granite.

The surface equipment, as much as possible, was complete before sinking operations were started. During the sinking of the first 700 ft. practically all of the hoisting was done in three compartments by a single drum hoist operated by a 50-h.p. motor, and a double drum hoist operated by a 70-h.p. motor. Three belt driven compressors, Ingersoll-Rand, Imperial, Type 10, each driven by a 50-h.p. motor, furnish air, at 90 to 100 lb. gage, to 12 Jackhamer drills. The air line, which is 6 in. wrought iron pipe, is for permanent use.

THE HEADER FOR HANDLING THE DRILLS.

This device shown in photo on Fig. 1 and in detail in Fig. 2 is a departure from ordinary practice. The header distributes the air to the drills and provides a safe and handy place for hanging them when not in use, one Jackhamer being shown on its hook in Fig. 2. When ready to drill, all that is necessary is to remove the Jackhamer from the hook and pull downward, the counterweight F keeping the slack hose out of the way while drilling.

In Fig. 2, A is a casting 9 in. in diameter, bored out in the center, and having a bolt circle of a standard 4 in. flange. Eight holes, evenly spaced, are drilled in the sides and tapped for ¾-in. nipples, to which the machine hose connections are made. B is a duplicate of A, with the exception that the holes for the nipples are of a different size. There are seven ½-in. connections and one 1 in., the latter being an inlet for the water and the others for water discharges to the drills. The

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*Abstract of a paper by J. M. Broan, Mining Engineer, Newport Mining Co., before the Lake Superior Mining Institute.

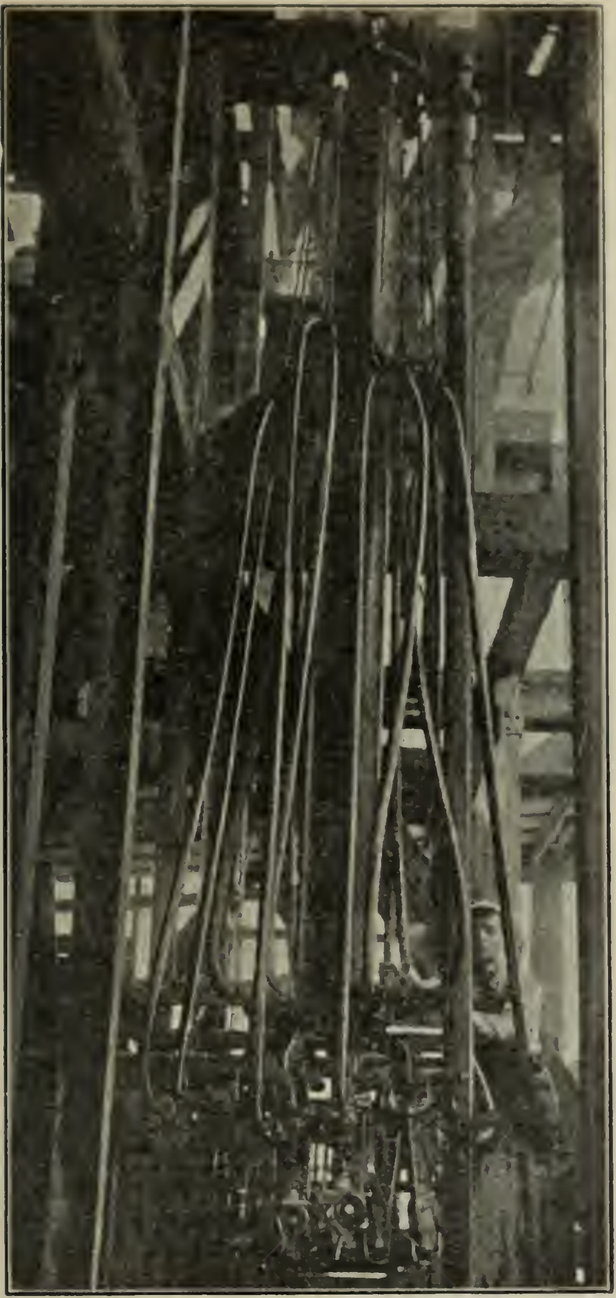

FIG. 1.

hooks or hangers marked C are made of ⅜ by 2 in. strap iron. There are four of these with a hook on each end. A B and C are all held together by four ¾-in. bolts passing through the 4 in. flange at the bottom of the 4 in. air pipe E. The ell at the top of the pipe is a special casting with a lug for the 1 in. eye bolt by which the header is suspended. D is a 9 in. pipe which serves as a casing to enclose the counterweights F.

Two of these headers are used, each accommodating seven jackhamers and one blowpipe, but only six machines are used on each at present. When in use each header hangs on a

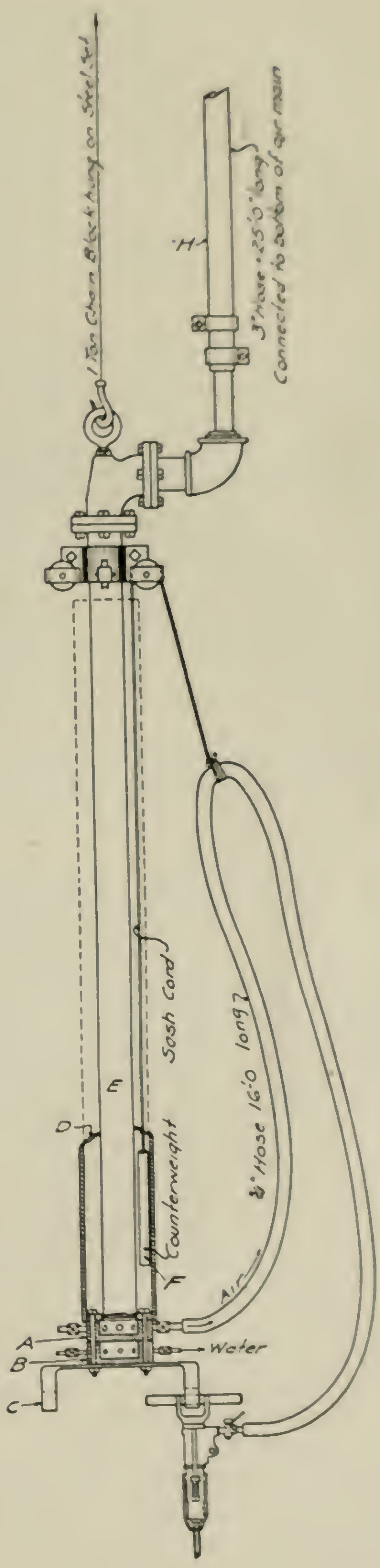

FIG. 2.

small chain block fastened to the bottom shift set. By means of the chain block the apparatus can be brought to any desired height, the adjustment being allowed by the use of a 3 in. air hose H, which connects to the air main, the bottom of which is always far enough up the shaft to avoid any severe blows when blasting. One of these outfits can be taken from its position on the surface and placed on the chain block below ready for drilling in less than five minutes.

While in the softer slates water tube pistons were used, and air was blown through them in place of water. A short piece of ⅜ in. rubber hose, shown in Fig. 3, delivered air from the ¾ in. air hose to the tube connections. Later when drilling in the granite the drilling speed was not as great, and it was found that sufficient air could be supplied through the ordinary piston to clear the choppings from the drill. The water tube pistons were then replaced by the ordinary pistons, and the bypass hose dispensed with, thus giving greater efficiency in air consumption, but no noticeable decrease in drilling speed. The steel, which is ⅞ in. hollow hexagon, is made up into lengths varying by 1-ft. changes from 12 in. to 10 ft., with ⅛-in. difference in gage for each drill; the first bit being 2¼-in.

Until the granite was reached, the four-point or cross-bit was used, but the wear on the gage became such as to warrant a change if something more serviceable could be found. It was then that the Carr bit was tried out. Considerable difficulty was encountered, especially in the stratified rocks, with fissured holes and stuck drills. Rather than abandon a hole much time was often spent in freeing a drill. It was here that necessity led to the adoption of the two pullers shown in Fig. 3. In case only a short portion of the steel emerged the long gooseneck, shown on the left, was used, while if two or more feet of the drill remained out of the hole, the shorter puller, shown on the right, could be applied. In either case the inverted jackhamer supplied the necessary power to extract the drill. While in the soft slates 10 ft. drills were used with very little difficulty, and sinks measuring as deep as 9 ft. have been blasted successfully. About 470 lin. ft. of drilling was required per cut in these slates and this could be completed in from 4 to 5 hours. In the hard quarzite dike and granite the gage on the steel would not hold up long enough to permit the use of any drill over 8 ft. long.

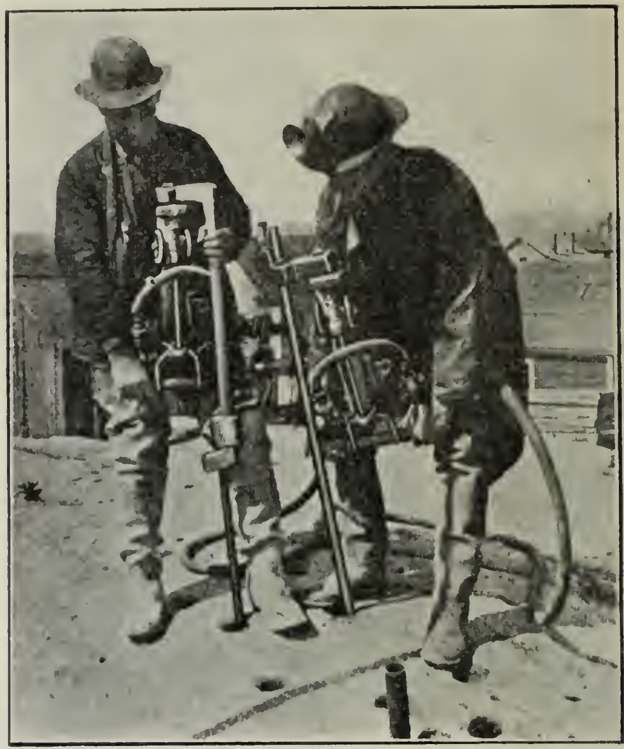

FIG. 3.

In these rocks about 425 lin. ft. of drilling is necessary, which can be done in 7 or 8 hours. The breaking of the holes is dependent entirely upon their arrangement and the order in which they are fired. Fig. 4 shows the plan and section of the arrangement and order of firing used while in the soft slates. Line AA represents a bedding plane on which the rows No. 1, 2 and 3 on the right were bottomed. The shaft was blasted in two separate blasts, the first being made on the right, and the holes blasted in the order numbered in the plan. Three holes marked No. 1 were fired simultaneously with No. 6 electric blasting caps. The exploders in the remaining holes were made up of No. 8 caps and electric delay fuse igniters.

A different arrangement of drilling and order of firing has been found more satisfactory in the granite. Fig. 5 shows 2 rows of holes marked No. 1 which are drilled about 5 ft. deep at an angle of 60 degrees; then 2 rows marked No. 2 about 8 ft. deep at an angle of 70 degrees. These 4 rows of 5 holes each comprise the cutting holes, which are fired in the order numbered in the plan. The 6 No. 1 holes are fired with No. 6 electric blasting caps,

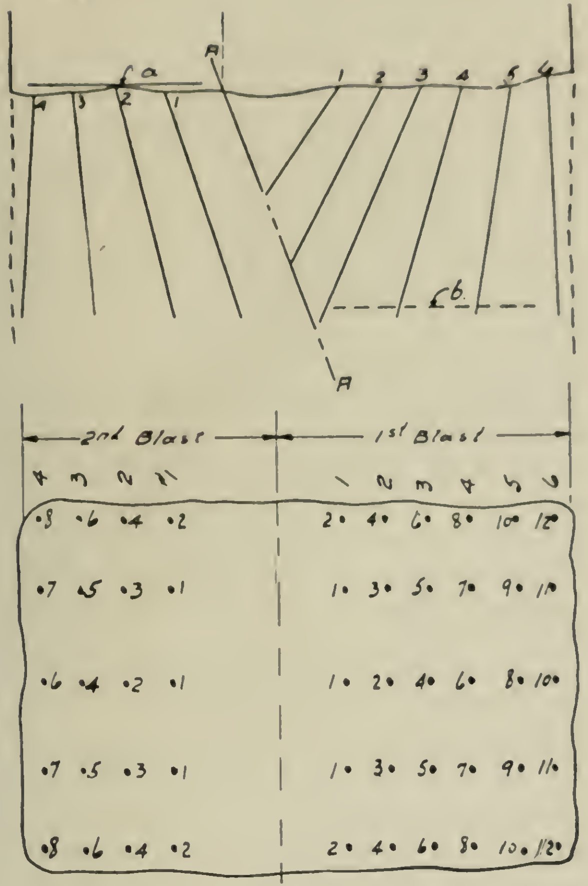

FIG. 4.

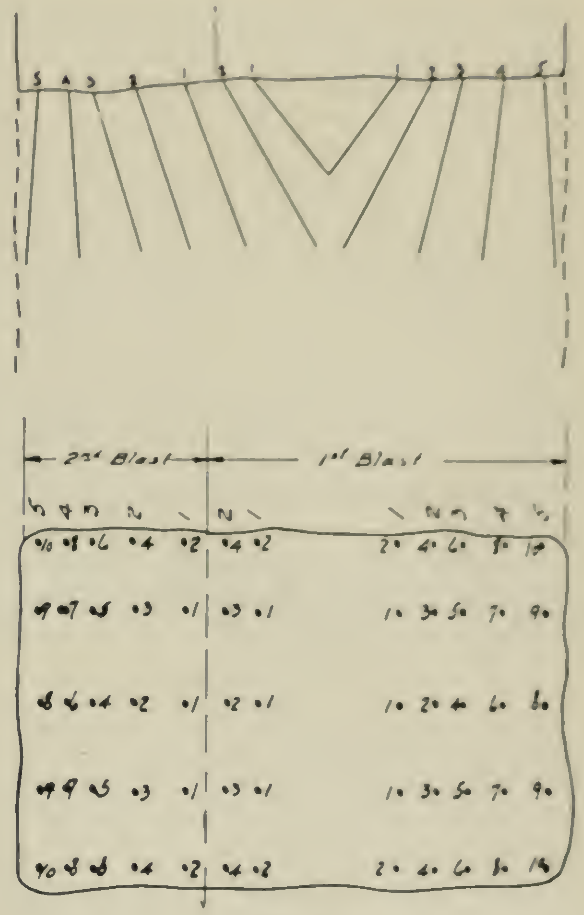

FIG. 5.

and the others with No. 8 caps and electric delay fuse igniters.

Since the steel used is only ⅞-in. in diameter, the bottom of a deep hole is, of course, very small and can not contain sufficient explosives to break the burden in a satisfactory manner. To offset this disadvantage as much as possible, without drilling more holes, two or three sticks of 100 per cent. blasting gelatine is placed in the bottom of each hole. The remainder of the charge with the exception of the cartridge containing the detonator is 80 per cent. blasting gelatine. Experiments by the DuPont people have shown that 60 per cent. nitro-glycerine gives a maximum efficiency for speeding up the action of a charge, and for this reason a single cartridge of this strength is used to contain the detonator. It is placed as near the top of the charge as considered safe from being cut off by the breaking of an adjacent hole. Cartridges of sand are used for tamping. An average of 26½ lbs. of explosives per foot of shaft have been used in the first 800 ft. or about 1 lb. for every 13 cu. ft. of excavation. In the first 1100 ft. about 2 lb. of explosive was used per cu. yd. of rock excavated.

After a blast the smoke is cleared away by means of a draft forced through a 12-in. pipe by a 7-h.p. fan, on surface. At first the fan was used to draw the smoke out, but by reversing the air current a marked advantage was noticeable in the time required to clear the smoke.

During the first 700 ft. of sinking the rock was disposed of by means of three buckets having a capacity of 26 cu. ft. each. In order to make shoveling as easy as possible, steel plates have been used as sollars, with considerable success. In Fig. 4 "A" shows the position of these plates, when the first blast is made. The breaking of the holes in this blast has a tendency to throw the rock to the position of the plates. In the second blast of the same cut the plates are placed in position "B" Fig. 4.

During the mining operations below the construction crew is employed placing sets, ladders, etc., above. All lighting is done by electricity. A single lamp is placed under each ladder sollar to light the ladder to the sollar below. At the bottom of the shaft, two clusters of four lights each are hung, one below the staging to give light to the miners and one above to give light to the construction crew. An electric signal system is used, the wires being run down the east side of the shaft beneath the ladders. By means of a jumper connected to a common return wire, either signal bell can be rung from every sollar.

The men employed in the shaft are as follows: One shaft captain, 3 shift bosses, 36 miners, 11 construction men, 1 electrician, 4 landers, 2 motormen, 4 hoist engineers, a total of 62 men.

The excavation commenced on March 1, 1915, and 1,129 ft., or one-half of the total depth, was completed in the first six months.

SAFETY.

The first step along the line of accident prevention was the use of hard hats. In order that no excuse can be made, every man is furnished with a hat made of felt treated with rosin and shellac. These hats are very hard and will resist a severe blow. No person is allowed to enter the shaft without one. Danger signs are placed in conspicuous places warning loafers to keep out. Movable sollars made of steel plates and operated by levers, are placed over the two compartments most used for loading supplies. When the bucket hangs at the brace the lever is thrown and the plates close in around the bucket making practically a complete cover of the compartment. All buckets when lowered from surface are stopped just above the point where the construction crew is working and are rung down from there by the men below. Owing to numerous infections in minor wounds, an antiseptic consisting of a 2 per cent. solution of lysol has been placed in the wash room used by the shaft men. To date no accidents of a serious nature have occurred.

COMPRESSOR CYLINDERS VICTIMIZED BY A SUPERINGENIOUS "ENGINEER"

An engineer was hired to operate this plant after it was put in service, and to familiarize himself with the equipment and keep an eye on the construction work he was put to work while the plant was under erection.

Part of the equipment was a small ice machine, with the usual compressor. While the erecting engineer was installing it, the engineer inspected the cylinders, which of course were not as smooth as they would be in a machine that had been run for a while, and he told the erecting engineer that he thought they were altogether too rough. The latter explained that they would wear down as smooth as glass in a couple of weeks or a month at the most, and that all new machines were that way.

After the erecting man had left, the engineer decided he would hurry the smoothing operation. There was a bag of fine emery left, which some of the erectors had used for grinding-in valves, and the engineer mixed this with oil and pumped a liberal dose into the steam and ammonia cylinders. After a couple of days he gave them another dose and still another at the end of the week, telling the oiler he was going to have a polish like looking-glass in a little while.

About a month later, answering a hurry-up call, the erecting man found that the head pressure was low and the back pressure high, indicating that the machine was too small for the system, which he knew was not the case. He placed the wristplate on the central position, opened the indicator connections and turned the steam on. To his surprise steam at apparently full pressure blew out of each of the cylinders. He removed the valve bonnets and examined the valve setting, which was the same as he had left it. Then he pulled out one of the valves. This bore a sorry resemblance to the one he had put in there a month before.

While the oiler and he were working, the former casually remarked that "Ben's emery and oil wouldn't put much polish on cylinders in such a condition." The erecting engineer nearly dropped his wrench, but managed to appear unconcerned. In a matter-of-fact way he answered that he did not think it would, and inquired how they had used it and how much. The next day two men with a boring bar were busy on the machine and one engineer was out "scouting" for another job.—*Thos. G. Thurston in Power.*

Gas and oil engines innumerable were exhibited at the Panama Pacific Exposition, but not one steam engine.

AIR CUSHIONS FOR ELEVATORS

BY FRANK RICHARDS.

There recently occurred in one of the large office buildings of New York what might easily have been a serious and perhaps fatal accident. This building, of very large area, although it is now not quite up to date for the locality, as it is only sixteen stories high, is served by a row of eight passenger elevators and one big freight elevator. These elevators are hydraulically operated, not by a long direct plunger but by a plunger of larger diameter and shorter travel with multiplying cables and sheaves to give the required lift.

These passenger elevators in the rush hours, morning and evening, and also at noon, are apt to be crowded to their capacity, and on the day spoken of, when the lunch hour rush was on, the water pressure pipe was broken off, thus suddenly letting off all the plunger pressure, and seven of the eight cars, mostly full of passengers, dropped from different heights to the bottom. No one was hurt, so that not a very big story could be made of it by the daily papers, but it was given out that the safety of the elevators, as thus apparently demonstrated, was due to the action of the air cushions.

As a matter of fact these elevators have no air cushions, and, speaking after the manner of men, it might rather be said that serious accident in this case was escaped rather by pure luck. The safety devices provided surely can claim no credit in the matter. The cars really did not have the absolutely free drop which we think of when accidents of this type occur. Not one of the hoisting cables was broken; they all held intact and retained their places upon their respective sheaves, the counterweights all remained fully effective, and of course the friction of all this apparatus had more or less braking effect; also, although the water pressure pipe gave out completely, the entire release of the sustaining water pressure, and the escape of the water from all the hoisting cylinders, could hardly have been instantaneous. These things doubtless concurred to check the rapidity of the descent of the cars, thanks to nobody.

In the elevators here spoken of there is not the slightest attempt to confine the air in the shafts for cushioning or safety purposes. There are in fact no individual shafts, the eight cars all traveling, with suitable guides, in one open space with no partitions between them, and also at each story the doors and the entire elevator front consist of open steel lattice work.

This conspicuous absence of the air cushioning device suggests the propriety of a little general remark upon the subject in the interest of public safety. Air cushions would seem to be almost the ideal safety device for elevators. They are no man's special invention, they do not necessarily involve any patented apparatus, it has been to no man's particular interest to push them, so that for these and similar reasons they have not been urged for adoption as have been many things less deserving. Nevertheless no big modern building can be said to be up to date without them, not only for their first ostensible safety function, but also, as will appear, as an essential detail in effective fire protection.

To those who have never given it a thought there is one rather surprising thing in the functional operation of an elevator air cushion, and that is as to the air pressure involved. There is one elevator in the world which is unique, and which may be said to be perfect as to its air cushion. This is an elevator built at Chicago for amusement purposes. The shaft of this elevator is a steel framed, glass lined cylinder 200 feet high and 30 feet in diameter. It carries a load of passengers in its car, up to 125 at a time, from the bottom to the top with a lookout through the glass all the way up and a free view in all directions when the top is reached.

PASSENGERS BLOWN UP THE SHAFT.

The passengers in this elevator are not hoisted by any of the usual means, but are literally blown up. The elevator car is practically a piston fitting the interior of the glass lined cylindrical shaft approximately air tight, and air pressure is applied under the car to do the lifting. And here is the wonder of it. All the air pressure required to lift the weight of the elevator car, and the maximum load mentioned of 125 passengers, is only a quarter of a pound to the square inch. No air compressor, but just a common foundry blower is all that is required to operate this elevator.

In making the ascent in this elevator, when the top is reached or at any point below the top, if the blower is stopped or if the inflow of air ceases, the car is still sustained by the cushion of air under it, and, as the car or piston must be assumed to be not perfectly air tight in the cylinder, some of the air will leak past the car and it will slowly descend to the bottom, air-cushioned all the way, but with the air pressure under it never greater than that due to the weight of the car and its load of passengers, or, as before stated, about ¼-lb. per sq. in.

This would be the case if the conditions were as described, but if the air cushioning operation should begin after a car had freely dropped a considerable distance, and after it had acquired a high velocity, then the air pressure required to check and overcome this velocity would be much greater, and if the additional distance to be traveled was small and the time allowable for the stoppage short, then the air pressure under the car might be too high for safety.

A personal acquaintance of the writer, probably forty years ago, who was an enthusiastic advocate of the safety air cushion, undertook to give a demonstration of it in connection with an elevator in Boston. Unfortunately he was not an engineer and was deficient in mechanical instinct, so that he gave no proper thought to the conditions essential to success and safety. At the bottom of the elevator shaft he built a cushion chamber of brick, too short to be called a shaft, into which the car was to drop and be cushioned by the air. On the first and only trial that was made he got into the car and was lifted to the top of the shaft, the cable was cut by his order, the car had a perfectly free drop to the bottom, the brick air chamber flew all to pieces and the poor fellow was killed.

Since that time the subject has been intelligently and thoroughly studied and there is now no guesswork or uncertainty about the elevator air cushion any more than there is about the means of lifting. It was remarked at the beginning that no specific inventions and no great ingenuity were required in the construction of the air cushion, but in bringing it so near perfection as it may now be claimed to be several valuable devices have developed which are now apparently indispensable.

Another surprise awaits the novice here in the small amount of air pressure required for effective cushioning when the work is properly distributed. The trick of it is to have a sufficient length of cushion shaft, so that a proper distance will be traveled and a proper time will be consumed for the cushioning operation.

Probably as typical as any of the up-to-date elevator air cushions are those of the Woolworth Building, and they could have no better opportunity anywhere. There are in the building 26 elevators traveling at a hoisting and lowering speed as high as 700 feet per minute. Two of the cars travel to the fifty-first story, 679 feet, two to the forty-sixth story, two to the fortieth story, and so on, four traveling only to the twelfth story. The air cushions for these elevators extend up to the fourth story for the lowest lifts and to the eleventh story for the highest. The shafts for the lower portions where the cushioning occurs are thickened and stayed to resist the internal pressures that will occur. The fit of the car bottom in the shaft of each is adjusted and graduated with care, so that there will be an approximately uniform pressure for the cushioning for the entire cushioning distance, and no excessive pressure at any point. There are in fact outlet valves distributed in the shafts and set to open at a pressure of about 12 pounds. The sudden pressures would of course rise above this in case of a drop. As the cars fit the shaft so closely there would be a power-consuming suction when lifting, and this is prevented by free moving automatic inlet valves. In the shafts above the cushioning portion there is space enough around the car to make the air resistance negligible.

The air cushions of these elevators have been subjected to practical tests under the most exacting conditions possible and their absolute safety and reliability have been fully demonstrated. As a sample incident, one of the cars loaded to a total weight of 7,500 lb., equal to that of a carful of passengers, was dropped freely from the forty-fifth floor and stopped by the air cushion with perfect safety. The car velocity in the cushion portion of the shaft was not checked with great suddenness, but gradually and with a nearly uniform resisting pressure, which did not exceed 15 lb., per sq. in. except at the last moment when a maximum of 18 lb. occurred.

Such being the facts in regard to the guarantee of safety which the air cushion gives to the elevator it would seem that its adoption should be as compulsory as that of a safety valve on a steam boiler, unless a device equally effective could be found, and there is none in sight.

The completely air tight enclosure of the shaft and the normally tightly closed doors which the air cushion demands are in all cases continued to the top of the shaft. This, while not necessary at the upper end of the shaft so far as the action of the air cushion is concerned, is a very important detail for the purpose of fire protection. The tight shafts and enclosed stairways completely isolate each floor from all the rest and prevent the extension of incipient fires, so that for this reason also the air cushion, and the conditions which it implies, should be insisted on, and in the most modern buildings they are so almost universally.

PNEUMATIC GRAIN ELEVATING PLANT*

Although the first successful pneumatic grain handling plants were constructed as much as twenty-five years ago, real progress can only be said to have been made in this direction in recent years. One of the early drawbacks was the great consumption of power. But, even with such an extravagant consumption of energy as 4 horse power per ton per hour, it was found that the early pneumatic apparatus possessed very definite advantages over mechanical means for some classes of work.

Pneumatic systems are coming more and more into favor for grain in cases where it would be difficult, if not impossible, to utilize purely mechanical means, while in many instances it will be found advantageous to have the two systems working together, the mechanical elevators taking out the contents of the main holds of ships, while the pneumatic appliances are left to deal with the discharging of the grain which is inaccessible to the former.

There are three main uses to which pneumatic plants can be applied with advantage — First, for discharging ocean-going vessels in port, and especially for cargoes consisting of a number of comparatively small parcels of various kinds of grain, which render the speedy and efficient discharging of the cargo a far more difficult task than is the case with ships carrying only one large consignment. This point is well illustrated by the accompanying diagram, Fig. 1, showing the actual stowage plan of a grain ship dealt with at a Scottish port. The cargo consisted of a large number of parcels of grain varying in size from 46 tons to 942 tons, which were stowed not only in the main holds, but also in the side bunkers, peak, and poop holds. In such cases ordinary bucket elevators are at an obvious disadvantage, as a very large amount of the work of discharging would have to be done by manual labor, which is both slow and expensive. With a pneumatic plant, on the other hand, the flexible piping can be introduced through any small opening or carried inside the vessel any distance so as to deal with the parcels stowed away in awkward corners of the ship. The cargo in the ship illustrated diagrammatically weighs altogether 5,188 tons, and if bucket elevators and manual labor only were available for discharging, probably 1,620 tons, or nearly 33 per cent., would be required to be "trimmed," as indicated by the cross section lines shown.

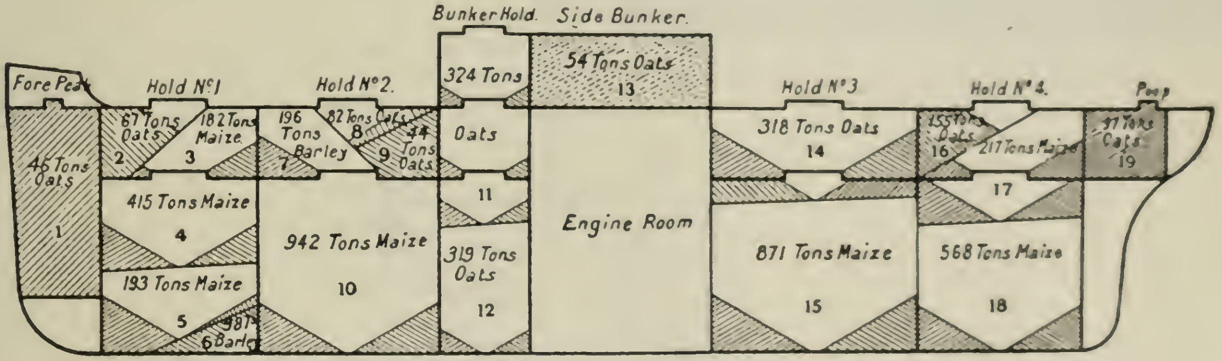

FIG. I. TYPICAL STORAGE PLAN OF A GRAIN SHIP.

A further advantage claimed for the pneu-

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*Condensed from *The Engineer*, London.

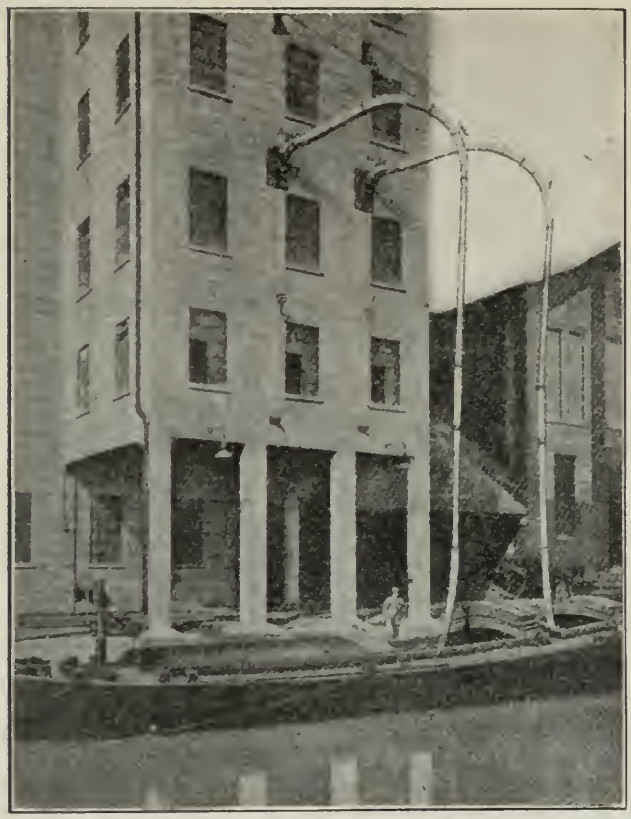

FIG. 2. PNEUMATIC GRAIN ELEVATOR FOR MANCHESTER SHIP CANAL.

matic system is that the work of discharging can be continued in all kinds of weather, as the hatches need only to be opened slightly to admit the suction pipes, and the grain is thereby protected from the effects of rain and wind. Still another advantage claimed for the pneumatic system is the beneficial effect of aspiration on the grain, particularly that which has become heated by storage for a length of time in the ship's hold. In passing through the apparatus the grain is cooled, and the dust which is removed can be returned, if necessary, for weighing purposes.

WHERE TO USE PNEUMATIC ELEVATORS.

In the cases of mills to which the grain is delivered in barges there are several points for consideration in deciding whether to adopt a bucket or a pneumatic elevator, such as, for instance, the comparative cost of labor and power; whether the water frontage is suitable for the employment of bucket elevators; whether the berth is large enough to enable the barge to be moved about—a necessity with the bucket elevator; whether in the case of tidal water there is stranding at low tide; and

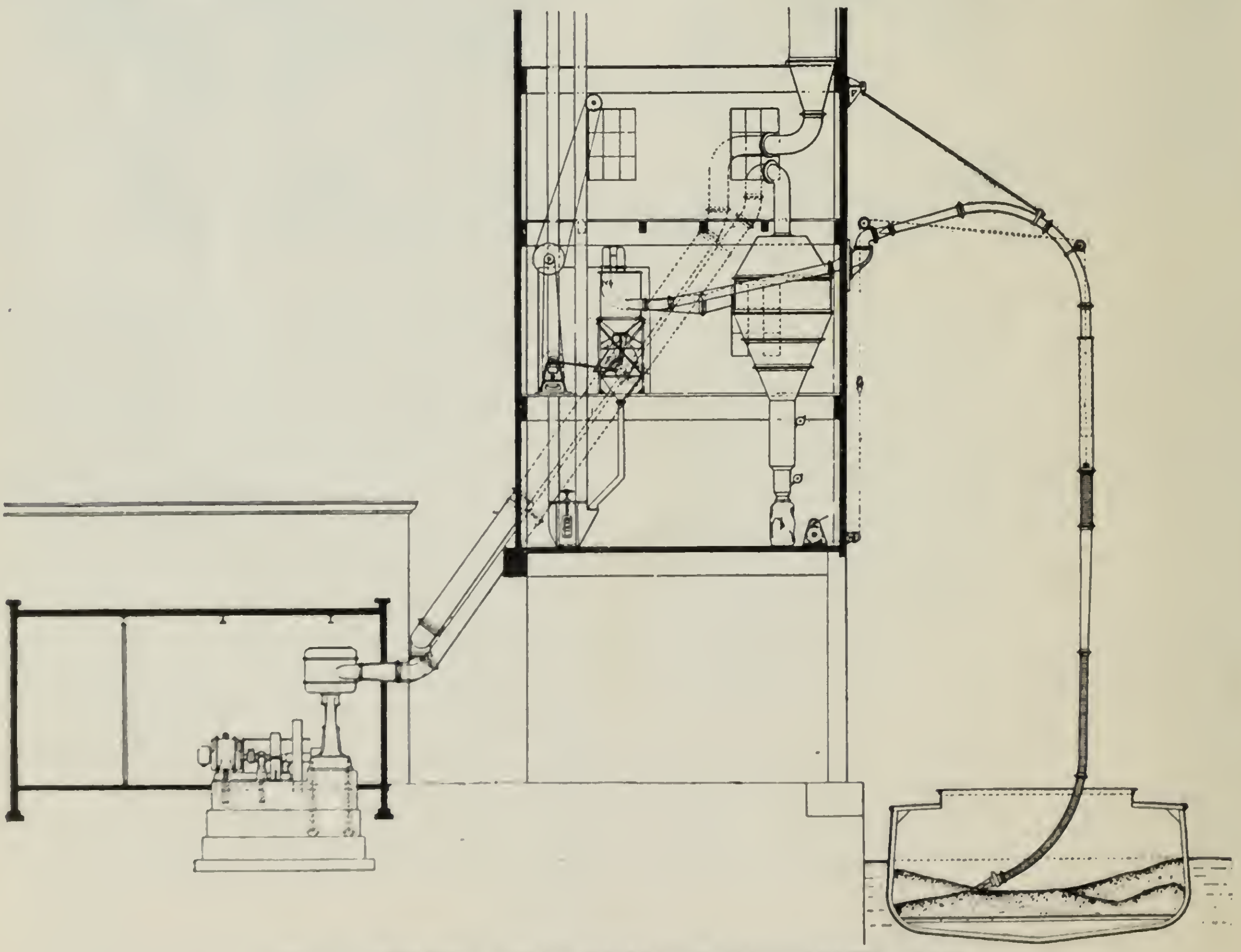

FIG. 3. GENERAL ARRANGEMENT OF MANCHESTER PLAN.

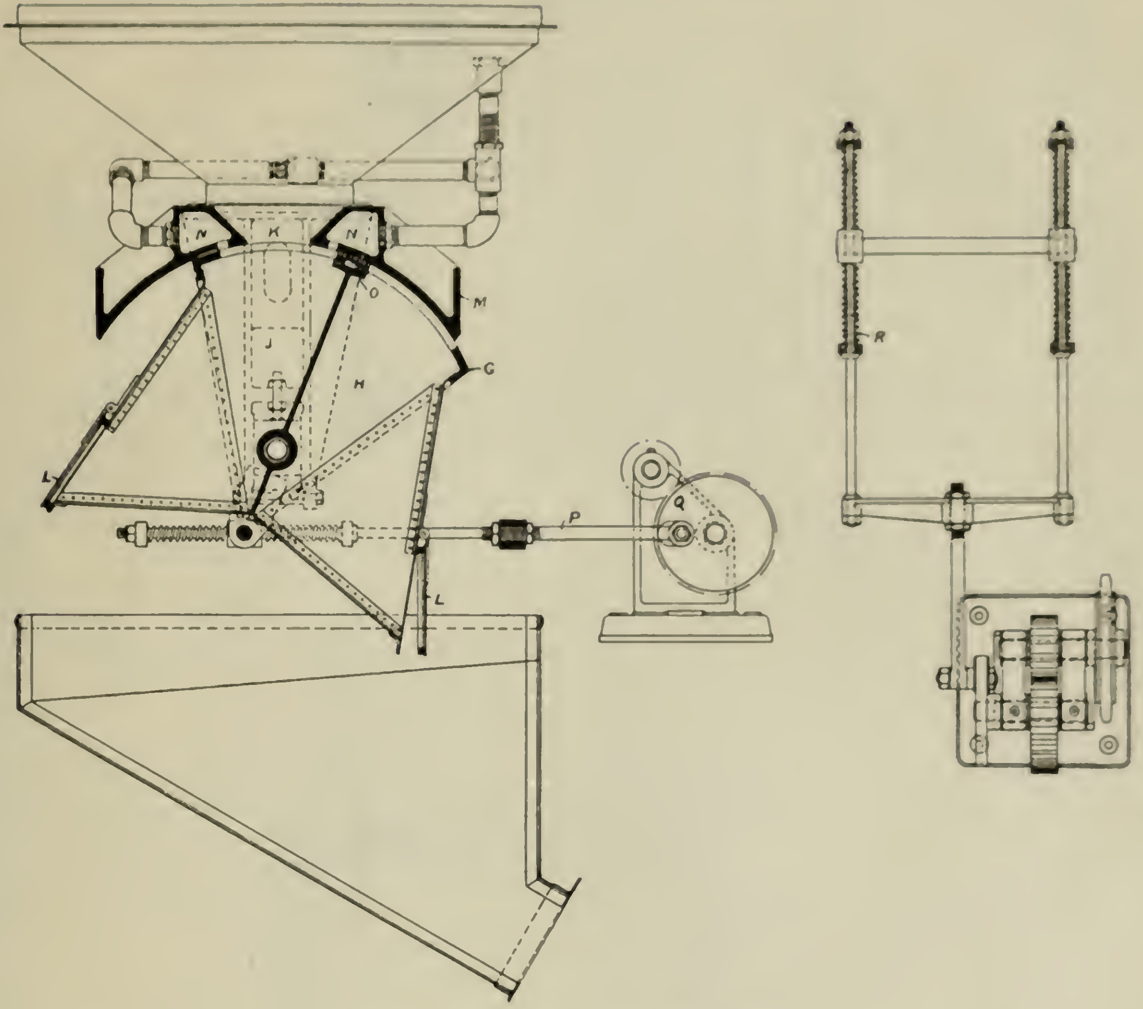

FIG. 4. DISCHARGE TIPPER SEAL.

finally the rise and fall of the tide. It will be admitted that as regards the power consumed the advantage will be with the bucket elevator, but as a set off to this it must be borne in mind that in passing through the pneumatic plant the grain is subjected to a cleansing action, and the work of the cleaning machines is thereby reduced.

Some illustrations are here given of a pneumatic grain elevating plant of 50 tons per hour capacity which has recently been erected by Henry Simon, Limited, Manchester, at the mill of John Jackson and Sons, Salford. This plant has been specially designed for unloading grain from barges in the Manchester Ship Canal, Fig. 2. The general arrangement of the plant is shown in outline in Fig. 3. The principal features are: an electrically driven vacuum pump, which it is not necessary to describe here, an improved form of discharging apparatus, Fig. 4, and telescopic grain suction pipes, Fig. 5.

The suction branch of the vacuum pump is connected by a 16 in. sheet steel main to a cyclone dust collector fitted with discharge valves to enable the dust extracted from the grain to be discharged into sacks. The inlet to the dust collector is connected to the grain receivers, in which the grain after being freed from dust is deposited. From the receivers the grain is discharged through the mechanically operated tipper seal shown in Fig. 4. The rocking member G contains two pockets H J, which are alternately brought into communication with the grain outlet K of the receiver. While each pocket is thus engaged and therefore under vacuum its hinged discharge door L is held closed by the pressure of the atmosphere. Simultaneously the other pocket has been swung far enough over to admit air through the feed opening and has permitted the hinged door to open and discharge its contents. The frame of the tipping box, including the circular rubbing face, is of cast iron, and is pivoted in adjustable bearings, the bearings being supported by brackets carried from the upper or seat casting M in which ports N are arranged for exhausting the air from the pockets before grain is admitted to them. The object of the latter arrangement is to prevent the inrush of air carrying the grain over and into the dust collector. The air-tight joint between the tipping box and the upper casting is made by two means. There is a steel packing strip O held in the cross bar between the two pockets against the face of the upper casting by bow springs, and at the sides and ends of the rubbing face of the tumbling box leather strips are provided. The hinged discharge doors are also rubber faced to make an air-tight joint.

The tumbling box is caused to oscillate through the desired angle by the mechanism shown in Fig. 4, comprising a crank and connecting-rod P and mechanism operated by a train of spur gear wheels Q. This gives ten tips per minute, which is sufficient to pass 25 tons of grain per hour. Interposed between the connecting-rod and the tippers are helical springs R, the object of which is to prevent damage to the apparatus in case of any solid body becoming jammed between the cross bar of the tipping box and the lip of the seating. It should be mentioned that the crank mechanism is adjustable to allow for the normal compression of the springs.

The grain and air enter the receiver in a tangential direction by way of a fixed pipe communicating with the movable intake piping. The latter is supported by means of a swivel joint enabling it to be slewed through an angle of 180 deg. in order to obviate the necessity of moving the barges more frequently than is absolutely necessary for discharging purposes. A feature of the intake piping is the rectangular section to prevent the concentration of the grain, which would cause undue wear and tear.

Another interesting feature of the intake piping is the special telescopic joint shown in section in Fig. 5. This enables the height of the nozzle to be varied to the extent of 10 ft., according to the level of the grain in the barge. It will be observed that in this arrangement the upper pipe slides inside the lower one to prevent the grain falling between the joint and causing jamming. The packing joint comprises a ring of soft self-lubricating packing A, held in place by means of a spring B and a bolted flange C. The packing rests upon a loose ring D, between which and the flanged end of the lower pipe is a rubber ring E. The whole of the packing can be readily taken to pieces by removing the nuts shown. The lower end of the pipe is raised or lowered by means of wire ropes carried over guide pulleys.

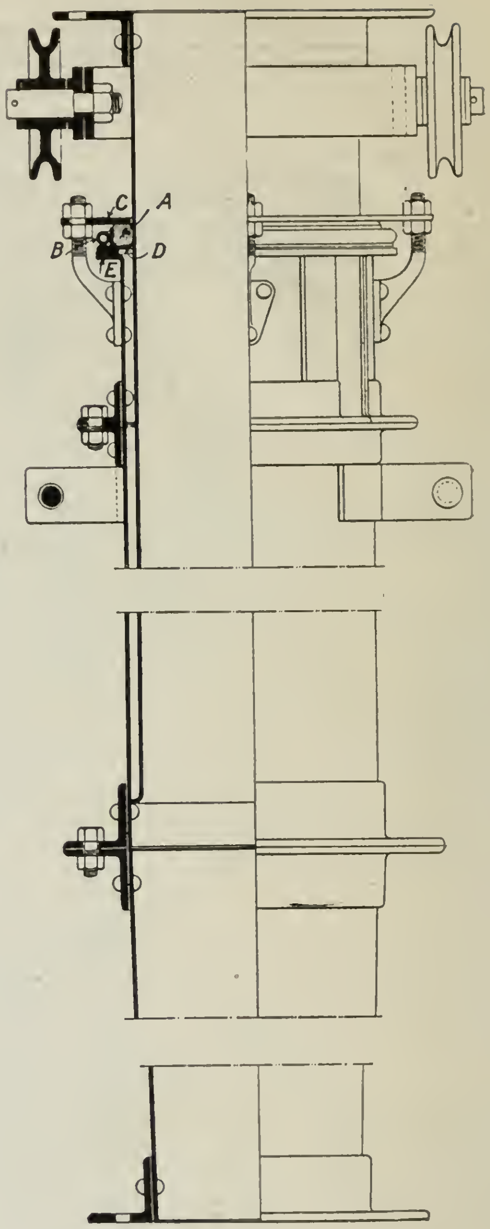

FIG. 5. TELESCOPE GRAIN PIPE.

A typical form of suction nozzle is illustrated in Fig. 6. It is built up of wrought iron plates acetylene welded and riveted, and consists of three parts, two of which form the duct by which the grain enters, and between these is the annular air chamber through which surplus air is admitted. The amount of air

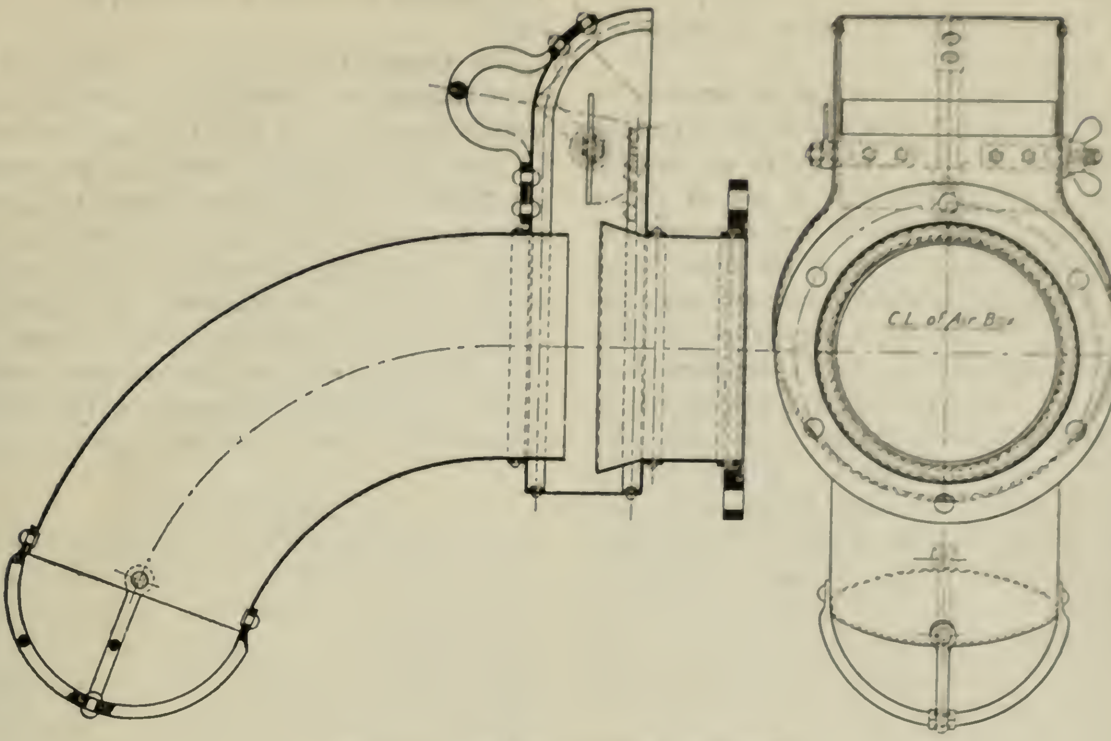

FIG. 6. GRAIN SUCTION NOZZLE.

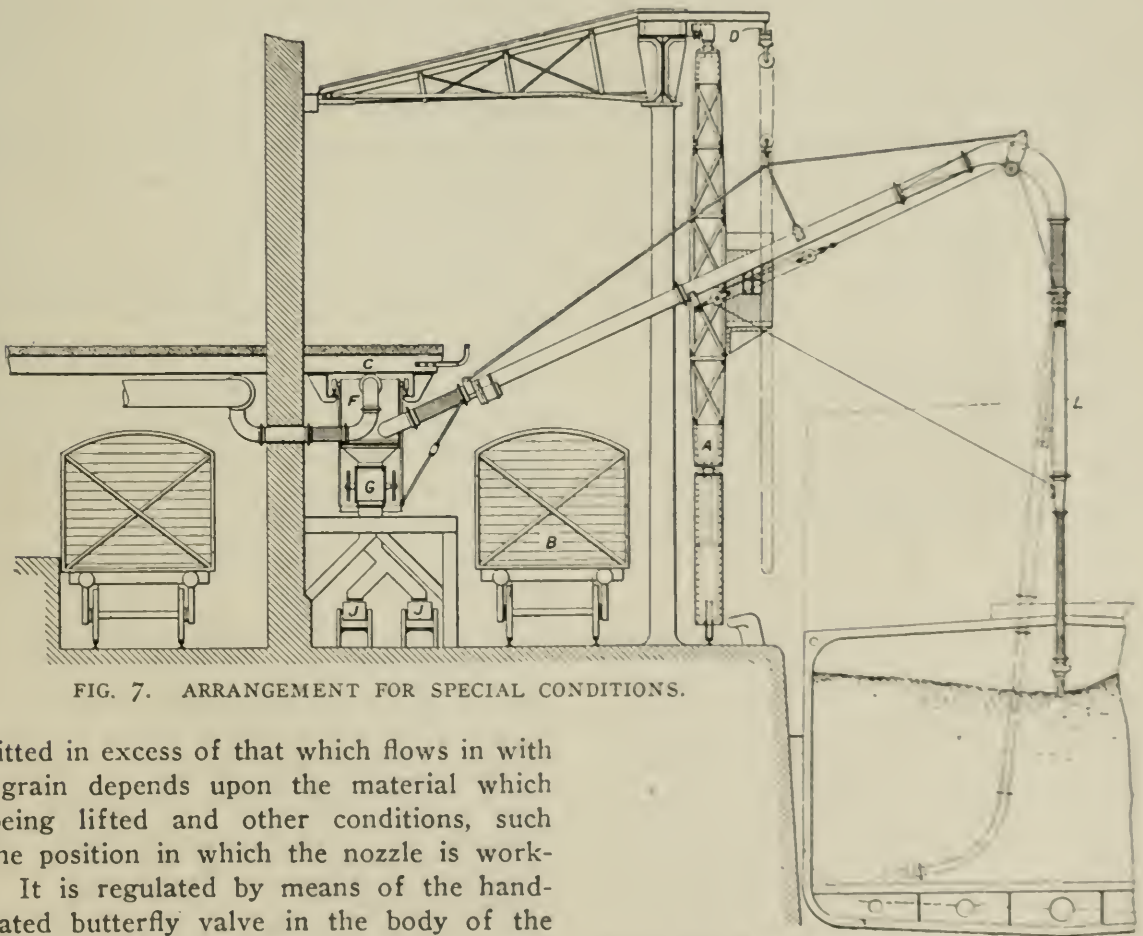

FIG. 7. ARRANGEMENT FOR SPECIAL CONDITIONS.

admitted in excess of that which flows in with the grain depends upon the material which is being lifted and other conditions, such as the position in which the nozzle is working. It is regulated by means of the hand-operated butterfly valve in the body of the nozzle.

Although we have no figures with regard to the power consumed by this plant per ton of grain per hour tests carried out on a somewhat similar plant in the neighborhood show that the expenditure is somewhat less that 1⅙ horse-power per ton per hour, which is a considerable improvement on earlier installations of the kind.

Fig. 7 is of special interest on account of the difficulties which have had to be overcome in adapting a pneumatic system to an existing situation. This plant is now in use at Carr's Flour Mills, Limited, Silloth, and is capable of dealing with 75 tons of grain per hour. The general principles on which it operates are similar to those of the above apparatus, but the pneumatic plant had to be so designed that it would not interfere with the operations of the existing hydraulic cranes A, or with the use of the railway siding B. It has to deal with the cargoes of both ocean-going and coasting vessels on tidal water, and the quay is encumbered by vertical columns, which support the crane girder. In order to get over these obstacles the main intake pipes L are made so as to be readily connected to and disconnected from the grain receivers F, and the receivers have to travel a certain distance. To do this they are suspended from rails carried by brackets underneath a loading out balcony C as shown. The intake pipes are suspended from a runway D, carried by brackets parallel with the quay and outside of the crane girder. This arrangement enables the pipes to be turned round and swung clear of the cranes. Owing to the restricted space available grain tipping mechanism such as that above described could not be used, and rotary seals G have to be employed. These are operated by electric motors through double spur reduction gear. There are six points along the quay at which the seals can be operated and connections made with the air mains. The seals discharge the grain on to conveyer belts J placed below the platform, which feed a silo at the end of the dock.

COMPRESSED AIR IN A SCOTTISH COLLIERY

At a meeting of the Scottish Branch of the National Association of Colliery Managers the presidential address, by Mr. Richard McPhee, described the system of compressed air haulage installed at the Bothwell Park Colliery. The colliery comprises two shafts both sunk to the splint coal. Owing to local conditions, the output of 1,000 to 1,100 tons per day of eight hours from both shafts is raised from the main coal level, 1,002 feet from the surface. The method of working is principally by longwall.

The system of haulage is direct-rope and main-and-tail rope, with compressed air as the motive power. The air is compressed to 70 lbs. per sq. in. at the receiver by two engines, one of which is of Walker's latest type, steam end cross-compound and condensing, with double stage air compressor. The speed at which it travels is regulated by a governor operated by air pressure from the main pipe, and also by the usual mechanical arrangement. The other compressor is of the coupled-tandem single-stage compressor type.

THE PIPING.

The compressed air is conveyed down the pit in a line of cast-iron pipes 8 in. in diameter. At the pit-bottom two branches, each 6 in. in diameter, are taken off (one for each pit). There are nearly six miles of pipes, varying in diameter from 5 in. down to 3 in. in use to convey the compressed air into the workings. The 5-in. and 4-in. pipes have screwed-on flanges with six bolts to each joint: the 3-in. pipes have strong oval-shaped flanges with two bolts to each joint. These joints have given the utmost satisfaction during many years of use, under the most trying conditions of heaving pavements and crushing sides

There are 21 haulage gears in the colliery all having double cylinders varying in diameter from 6 in. to 9½ in., with drums ing in diameter from 20 in. to 3 ft There are also 11 Tangye pumps with cylinders varying in diameter from 4 i 12 in., and with pump barrels from 3 6 in., and lengths of stroke in proportion

With one exception the seams worked all bad roofs, which are further aggra by working the one seam over or under main roads of the other for commercial sons. This compels the adoption of a sy of haulage which can work in a small r so that back brushing and repairing costs be kept within proper limits. For many y secondary haulage by a mixed system ponies and hand-drawing was in use owing to the heavy cost of maintaining roads high enough for ponies, and the reliability of the drawers, it was decided abandon it, and to lay off the workings such a manner that mechanical haulage co be applied right up to the face on slopes heading roads, leaving the men only the branch roads to draw. It was also decided where possible to apply conveyors on a line of face to give an output of coal large enough to justify the putting in of a separate haulage, the terminus wheel of which could be kept quite close to the bridge, thereby dispensing with ponies and hand-drawing altogether.

From the experience gained in the working of this extensive system of secondary haulage with compressed air as motive power, the writer believes the same results could not be obtained with electricity.

HIGH EXPLOSIVES*

BY PROFESSOR VIVIAN B. LEWIS.

PROPELLENTS AND HIGH EXPLOSIVES.

The difference between a "propellent" and a "high explosive" is entirely one of rapidity in explosion. In both cases they are bodies containing in a small space combustible material that can be burnt to form enormous volumes of gaseous products, together with oxygen-bearing radicals capable of carrying on the combustion with great rapidity independently of the exterior air. In gunpowder there is carbon in the form of charcoal, mixed with sulphur and potassium nitrate, the latter being the oxygen-carrying body, and on the powder being ignited a chemical action takes place, which liberates an amount of gas many hundred times the original volume of the powder. This conversion takes a measurable time for its completion, and a "propellent" is the result. On the other hand, when cotton is treated with the strongest nitric acid and mixed with sulphuric acid, the cotton fibre becomes nitrated, and a molecule is produced in which there are present the hydrogen and carbon of the cellulose, together with oxygen held in combination by the inert nitrogen of the nitrate radical. On such a compound being ignited it burns with considerable rapidity; but in a gun the rate of combustion is often accelerated, and a still more rapid form of explosion takes place.

It was in 1868 that one of Sir Frederick Abel's assistants, Mr. E. O. Brown, discovered that when a mercuric fulminate cap was exploded in contact with compressed guncotton the unconfined mass exploded with enormous violence, and that whereas an ordinary train of guncotton would take several seconds to burn a few feet, yet if compressed guncotton were detonated the explosion travels at the rate of 200 miles a minute, and as there is no time for the displacement of the air, the enormous volume of gas created having to find room for itself gives as great a destructive effect as if the guncotton had been tamped into a bore-hole in the object to be destroyed. Bodies which are capable of this accelerated form of explosion are said to be "high explosives," and unless the tendency to detonate can be overcome, as in the making of cordite from nitroglycerin and nitrocotton, they cannot be used as propellents, as there would be no time to overcome the *vis interia* of the projectile and the gun would be either strained or burst.

HIGH EXPLOSIVES TOO "HIGH" FOR USE.

Nitroglycerin is a very good example of a high explosive, but practically is of no use in Service work outside the manufacture of cordite, as it is far too dangerous to handle, and if used in a shell would be liable to premature explosion. It must always be remembered that science could provide explosives more powerful than those in Service use were it not quite as important to ensure safety for those using the explosive as to obtain destructive effects on the enemy.

EXPLOSIVE EFFECTS DOWNWARD

With most of these high explosives the explosion gives rise to its greatest effects in a downward direction, which may be explained by the fact that the decomposition is so enormously rapid that there is no time to displace the atmosphere, and the recoil from the attempt to push up an elastic medium like air causes the smashing down of rigid bodies below the seat of the explosion.

One of the things that strikes the ordinary observor most when considering the composition of the explosives of to-day is that they are all derived from substances of the most commonplace and harmless description. Cotton and glycerin when nitrated and blended with vaselin yield cordite, which serves as a propellent in all our guns, whilst the high explosives used in shells, torpedo heads, mines, and aviators' bombs, are almost entirely derived from coal tar derivatives by nitration.

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*From a Fothergill Lecture delivered before the Royal Society of Arts.

COAL TAR DISTILLATIONS.

When coal tar is subjected to fractional distillation the portion which comes over up to a temperature of 150 deg. C. is called "light oil;" it contains all the compounds of low boiling-point found in the tar, and from this several of our most valuable explosives can be obtained. When these light oils have distilled over, the next fraction or "middle oil" yields phenol or carbolic acid, a body which when nitrated gives picric acid, the basis of the French high explosive melinite, the Japanese shimose powder, and the English lyddite.

In the manufacture of picric acid the fraction coming over on the distillation of the tar between 150 deg. and 200 deg. C., after the naphthalene has been allowed to settle out on standing, is agitated with a solution of caustic soda, which forms sodium phenolate with the carbolic acid. This sinks to the bottom of the vessel and is drawn off and treated with sulphuric acid, whereby the carbolic acid is set free. The acid mixture is fractionally distilled, and the phenol comes over between 180 deg. and 190 deg. C., crystallizing from the distillate in needle-shaped crystals. Phenol or carbolic acid when pure fuses at 42 deg. C. and boils at 182 deg. C. The phenol is mixed with an equal weight of concentrated sulphuric acid, and heated in an iron vessel to a little over 100 deg. C. When cold the mixture is dissolved in twice its weight of water, and added gradually to three times its weight of strong nitric acid, precautions being taken to prevent undue rise of temperature; when fuming has ceased steam-heat is employed to complete the nitrification. On cooling, crystals of picric acid separate out and can be purified by crystallisation.

PICRIC ACID.

Picric acid is a nitro-substitution product, three atoms of the hydrogen in the original phenol being replaced by the radical nitryl, and it forms with metals a class of salts called "picrates." The potassium salt was suggested as a bursting charge for shells nearly fifty years ago, whilst Sprengel showed it could be detonated, and, later, Turpin employed the acid itself as an explosive. It was found possible to get a great weight of explosive into a small space, as the acid could be melted and poured into the shell in a molten condition. Picric acid *per se* is a very safe explosive, but has the drawback of acting on metals to form picrates, some of which are far more sensitive to disturbing influences than the acid itself.

Experiences with lyddite shells in the South African War showed their behaviour to be very erratic, some exploding with great effect whilst others gave disappointing results. This was due to the fact that picric acid requires a powerful detonator for obtaining the highest explosive effect, and the use of such a detonator was dangerous and might cause a premature explosion of the shell within the gun.

The disadvantages inherent in the use of picric acid led to attempts being made to replace it by some other material of the same character, which could be used as a high explosive in a bursting charge and yet be free from these drawbacks. Such a body has been found in trinitrotoluol, and although its explosive force is slightly less than that of picric acid, the pressure of the latter being 135,820 lbs. on the square inch as against 119,000 for trinitrotoluol, yet its advantages more than compensate for this difference. Not being of an acid nature, trinitrotoluol, or T.N.T. as it is termed, cannot accidentally form more sensitive salts; it is without action on metals, and is perfectly stable.

TRINITROTOLUOL.

Trinitrotoluol is obtained by the nitration of toluene, which is contained in the crude benzol distilled from coal tar and washed out from coal gas, and forms one of the groups of so-called aromatic hydrocarbons. The crude benzol contains roughly—

Benzene	50	per cent.
Toluene	36	"
Xylene	11	"
Other bodies	3	"

The toluene is obtained by careful fractionation of the crude benzol, the boiling-point being intermediate between those of benzene and xylene:—

	Specific gravity.	Boiling-point.
Benzene	0.886	80.5
Toluene	0.869	110.0
Xylene	about 0.87	137—140

When coal is distilled at the lowest possible temperature the tar is fairly light as regards specific gravity and of an oily character, is rich in paraffin hydrocarbons, and contains but few aromatic hydrocarbons. The distillation of a ton of coal yields about 20 gallons of such tar, the constituents of which are even of greater value than those of the high-temperature tar made in the gasworks and coke ovens of the Empire. On now raising the temperature of distillation of the coal to about that which used to be employed in the days of the old iron coal-gas retorts, a volume of coal gas, amounting to about 9,000 cubic feet, is yielded, the coke is harder in quality, and the tar shrinks from about 20 gallons to about 16 gallons to the ton. Tar made at this temperature contains a much higher proportion of aromatic hydrocarbons than that made at the lower temperature, and it is possible to obtain nearly a gallon of toluene per ton of coal distilled by recovery from both the tar and gas.

At the temperature used in practice at the present time for the manufacture of both coal gas and metallurgical coke, which is as high as the materials of which the retorts and ovens are constructed will stand, the aromatic hydrocarbons are largely destroyed or converted into naphthalene, and a third of a gallon of toluene is all that can be obtained from the tar and gas yielded by a ton of coal.

Toluene, to be used for the manufacture of trinitrotoluene, should be a clear water-white liquid, free from any suspended solid matter, and having a specific gravity of not less than 0.868 or more than 0.870 at 15.5 deg. C. Its boiling point must approximate closely to 110 deg. C., and 90 cc. shaken with 10 cc. of 90 per cent. sulphuric acid for five minutes should give only a slight colour in the acid layer after settling.

TRINITROTOLUENE.

The preparation of trinitrotoluene is carried out in three distinct stages, the toluene being converted first into the mono-nitro compound, which is then further treated with nitric acid at a slightly increased temperature to convert it into the dinitrotoluene, this being finally nitrated in sulphuric acid solution with strong nitric acid to trinitrotoluene.

On a large scale, trinitrotoluene is manufactured commercially from the orthonitrotoluene by a sulphonating process of the same character as that used in the manufacture of picric acid, and the crude crystals obtained in the final nitration are purified by solution in alcohol, filtration, and recrystallisation, the crystals being freed from alcohol in a centrifugal machine and air-dried

Trinitrotoluene when pure has no odour and is a yellowish crystalline powder, which darkens slightly on keeping and has a melting point of 81.5 deg C.; the presence in it, however, of isomers lowers its melting-point to 79 deg. C. It is perfectly stable and unaffected by contact with metals, forming no compounds with them even in the presence of moisture. It cannot be exploded by flame or strong percussion, and a rifle bullet may be fired through it without any effect on the mass. When heated to 180 deg. C., it ignites and burns with a heavy black smoke; but when detonated by a mercuric fulminate detonator the explosion is of great violence, and gives the heavy black smoke which has been such a characteristic of the high-explosive shells used in the present war. Even when detonated under water, as has been the case on several occasions with bombs aimed by aviators at vessels, a column of black smoke is thrown up above the surface of the water.

BLACK SMOKE.

The formation of these volumes of black smoke on detonation of the T.N.T. has given rise to the names given to shells containg this explosive of "Black Marias," "Coal boxes," and "Jack Johnsons," and the fact that this cloud of carbonaceous matter is produced shows conclusively that the oxygen contained in the nitryl radical present in the explosive is insufficient for its complete combustion. An excellent explosive used during the Balkan War, and now largely employed by the Austrians and Russians, is known as ammonal, in which 12 to 15 per cent. of T.N.T. is mixed with an oxidising compound, ammonium nitrate, a little aluminium powder, and a trace of charcoal. This mixture gives even better results than the T.N.T. alone, and its only drawback is the hygroscopic character of the ammonium nitrate, which necessitates the material being made up in air-tight cartridges. It forms, however, a most effective bursting charge, and although the rate of detonation of the trinitrotoluene is reduced by the admixture of the oxidising compounds, the shattering effect is even more destructive than when the explosive is used alone, as the pieces of shell scattered are larger in size.

An improved form of this explosive is being made on a large scale in England for use by the Allies, and renders the supply of high explosives for shells perfectly adequate.

Touluene is also being produced synthetically from other hydrocarbons by the action of heat and pressure, and it is safe to say that any requirements for toluene to nitrate can be amply met.

Under the influence of nitration other constituents of tar are converted into effective explosives, dinitro-benzol being the basis of such mining explosives as "Roburite" and "Bellite," whilst trinitrocresol has been used largely in place of picric acid under the name of "Ecrasite," but it shares with picric acid the drawbacks of forming more sensitive compounds with bases, and of having an acid reaction.

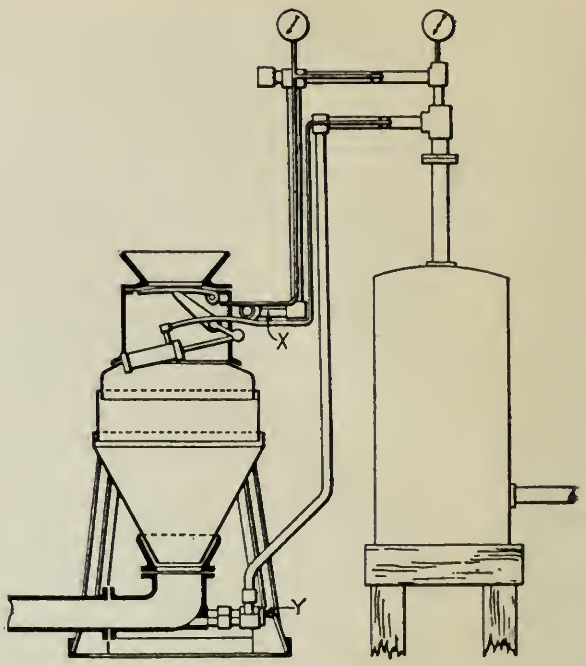
Probably the most powerful explosive known is made from benzene by converting it into anilin, and by nitration making this into tetranito-anilin, an explosive of which a great deal more will be heard, whilst another derivative, tetranitromethylanilin, known as "tetryl," is being used largely for detonators in place of mercuric fulminate.

PROPER REGULATING OF AIR PREVENTS CLOGGING OF PNEUMATIC MIXERS

BY H. A. LEEUW.

Proper application of an ample supply of compressed air has overcome clogging in the conveying pipe in placing concrete by the pneumatic method. This clogging has been the most serious drawback to the use of this method of mixing and placing concrete, which has developed until concrete has been placed at a distance of 2,800 ft. at the Mile Rock tunnel in San Francisco, and raised to a height of 60 ft. in building piers for a bridge at Magnolia, W. Va.

Owing to the way in which different aggregates behave in feeding into the conveying pipe, the air has to be supplied differently for stone and gravel. The illustration shows a cross-section of the mixer and inlet pipes, which are designated by *X* and *Y*. To illustrate the above statement, when gravel is used, it has been found that it was necessary to admit air only through the inlet marked *Y*, as an application through both would cause the material to feed too fast into the conveying pipe, and would result in a clogged pipe. When stone is used, however, it is necessary to apply the air through both inlets. If only the inlet *Y* is used, the material will arch and then suddenly fall down to the discharge pipe, causing it to clog.



AIR VALVES ON CONCRETE MIXER.

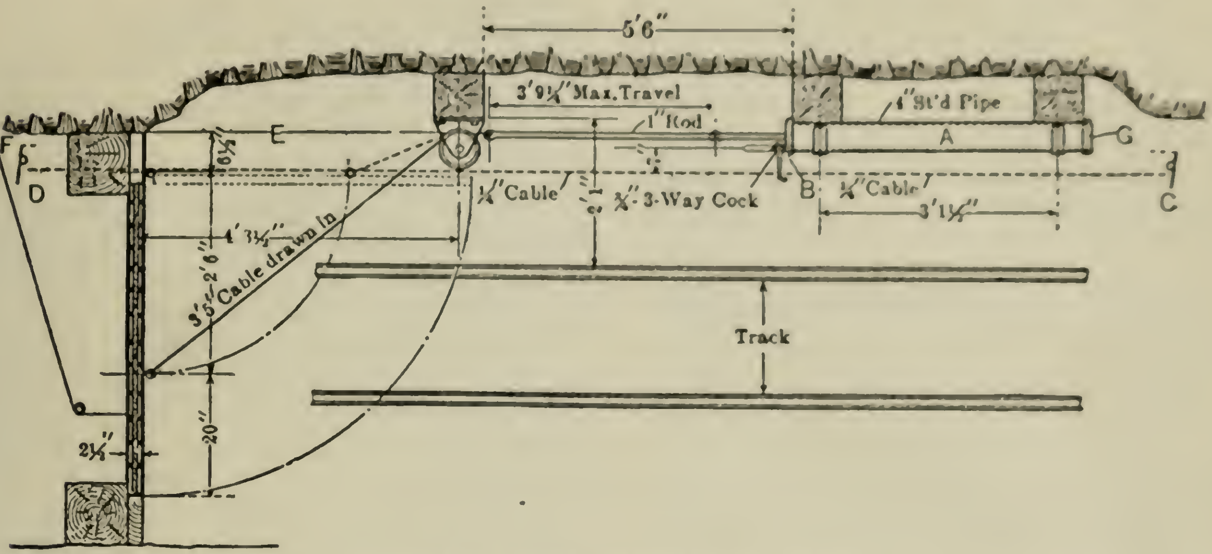
It is very important to have a sufficient volume of air to carry the concrete through the delivery pipe to the forms. When this has not been properly taken care of, the concrete will drop in the delivery pipe and the next batch will stick on this and clog the pipe. The tendency has been to under-estimate the number of cubic feet of free air per minute required, as till lately there has been little information available on this subject. The following table

CUBIC YARDS OF CONCRETE PER HOUR, MIXER CAPACITY ½ CU. YD.

Actual amount of compressed air required. Cu. ft. of free air per minute	Length of Horizontal Discharge					
	100 Lin. Ft.	300 Lin. Ft.	400 Lin. Ft.	600 Lin. Ft.	800 Lin. Ft.	1000 Lin. Ft.
600......	20	15	10	..	..	..
800......	30	20	18	12	6	..
1200......	40	30	25	20	12	8

shows the result of three years of study and practical experience. Present satisfactory installations are proving the correctness of these figures.

It has been found that the character of the sand plays a more important part, with reference to the speed with which the mixture is carried through the pipe, than does that of the stone or gravel. A sharp, clean sand will require less air to move concrete mixed with it than one in which the percentage of loam or oxide of iron is high.



AUTOMATIC MINE VENTILATING DOORS.

It has also been found that a pressure of 90 lb. per square inch gives the best results. This pressure, expanding into a 6 or 8-in. pipe, depending on the size of stone or gravel used, is reduced to a pressure averaging about 25 lb.

HOSE AT DELIVERY END REDUCES KICK

This high pressure has presented an obstacle to be overcome, as the delivery end must be securely fastened to take care of the kick resulting from this pressure. After considerable experimenting, it has been found that a hose, the lining of which is made of pure rubber to withstand the wear, and reinforced to take care of the thrust, when connected a short distance from the delivery end, acts as a shock-absorber, and allows the discharge end to be handled, so that the concrete is not all deposited in one place, but may be distributed in even layers. The mixture of the concrete placed in this way has been found to be as perfect as that delivered by any of the mechanical mixers on the market. When, however, the volume of compressed air falls below the amount required, as shown in the table the mixture shows a tendency toward segregation.

The pneumatic method is well adapted to tunnel lining, as it is possible to secure an increase of at least 50 per cent. in speed with a corresponding decrease in labor. The usual labor crew consists of six men for an outfit which is placing concrete at the rate of 100 cu yd. in a 10-hr. day.—*Engineering Record.*

COMPRESSED AIR AUTOMATICALLY OPERATES MINE VENTILATING DOORS

At Copper Queen Mine the fan draws the air down the Gardner and Spray shafts and forces the total quantity into the workings on the 900-level. Part of this air goes down to the 1,000-ft. and later comes up to the 900-ft., from whence all the air passes through stopes to the 800, 700 and 600-ft. levels, and exhausts through abandoned workings and upcast shafts. On the 1,000-ft. level the pressure is built up by the use of automatic doors. These doors not only hold the pressure, but also allow the air to circulate freely on the 1,000-ft. level. The usual speed of motor trains passing through these doors is about 7 miles an hour. The doors are 350 ft. apart. The arrangement for automatically opening the door is shown in illustration.

When the motor comes in the direction of *C* to *D*, the motorman reaches out and moves the lever *C* in the direction the motor is going. This opens the 3-way valve *B*, admits compressed air into the cylinder *A* and opens the door. When the train has passed through the door the motorman throws the lever *D*, which releases the compressed air and the door closes, assisted by the weights *E* and *F*. The valve *G* controls the speed of opening and closing of the door. The wires between *C* and *D* are crossed so that the levers are always moved in the direction the motor is going in opening and closing the door. The distance between lever *C* and the door is 70 ft., which allows ample time for the door to open when the motor is coming at an ordinary rate. The distance between *D* and the door is 175 ft. This makes it possible for a trip of cars to be in front of the motor on the return and at the same time allow the door to be opened. The cost of upkeep is small and the entire equipment only requires the amount of attention usually given to any machine.—*Min. and Eng. World.*

ANEROID BAROMETERS FOR AVIATORS

BY P. RICHARD JAMESON, F. R. MET. SOC., F. R. S. A.

Ordinary aneroids provided with altitude scales such as tourists carry have been often used to determine the height of a flight. Needless to say, their results will not bear critical investigation, for these particular types are not adapted for work where rapid changes in atmospheric pressure take place.

Again, the construction of their dials is of a character that may cause many people to unknowingly use them incorrectly. A climb of hundreds of feet a minute of which certain aircraft are capable demands a differently constructed barometric mechanism than does a flight which consumes two or three hours in attaining the same elevation.

Altitude barometers are operated by a diaphragm opening or closing as changes in the weight of the air occur. There is a certain "lag" on all aneroid barometers, and it is impossible to absolutely eliminate it. The metal used in the diaphragm is of a very very fine gauge. In delicate instruments it is around 0.004 inches in thickness. This is corrugated and is circular in form, so that the corrugations offer elasticity. This diaphragm soldered around its edge appears as a small box. The air can now be exhausted from it. It naturally collapses, but a strong spring is fitted above it which draws it open again, keeping it in balance with the air. Any greater air pressure closes it, while a lesser air pressure enables the spring to open it more. This creates an up and down motion as the mechanism is taken to different air levels. By means of a series of levers this motion is transmitted to the dial. It is a well known fact that all altitude aneroid barometers need "recovery" after an ascent, for the hand will not often return immediately to its starting point, but will sometimes "recover" considerably in a few minutes, full recovery taking some hours, more often a day.

This is due to the "stress of metal" in the diaphragm; it is elastic, but has opened so rapidly that it has become somewhat strained and on its return to a low level remains "stretched" for some time, the amount differing in all instruments.

It is obviously necessary therefore to use an altitude instrument whose diaphragm is adjusted in such a manner that the maximum of "stretch" or "stress" has been removed by mechanical or other methods.

I have used altitude aneroids a great deal and have had considerable experience with them for the past twelve years and know this "stretch" and "rest" process to be a fact, and also that it varies with the instrument.

[In this connection the effect of changes of temperature, and the time required for equalization after such changes, should not be forgotten.—*Ed. C. A. M.*]

In ascents on Mount Cook, New Zealand, to elevations exceeding 10,500 feet; in the Himalayan Mountains in India to elevations exceeding 7,000 feet, both places showing extremes of temperature, I have found my ordinary pocket (3-inch) altitude barometer checked up very correctly, for no other reason than because it is a good instrument and because the ascents were slow and the "recovery" process did not occur, or else was taken care of in the course of the naturally slow ascent and descent. In returning to any base it has invariably checked up accuriately with standard instruments.

When used in an aeroplane it shows a considerable deviation from standard readings when it is brought to a low level, proving that it suffers as all altitude instruments from "stretch," but after a "rest" it completely recovers itself.

Special "aeroplane barometers" are constructed in some way to offset a great deal of this bothersome "stretch" and as a consequence they return to, or nearly to, their zeroes. I have in my possession a 4-inch instrument by Short & Mason, London, reading upwards to 7,000 feet, certified at the National Physical Laboratory, showing a maximum error of but 50 feet. It possesses only an equally divided altitude scale, which is really the one in which a pilot or observer is interested. As this scale is made to revolve, the indicator can always be adjusted so that it starts its indications from the "O" feet reading.

This is impossible without error on the smaller size aneroids or types constructed for tourists to carry in the pocket, as their scales are unequal in division, and are correct only when the "O" feet of the altitude scale or the "31" inch mark on the pressure scale are coincident. Should the scale be moved from this point the error is against the aviator going in for "altitude," as the results indicated by the aneroid are less than the actual results attained by the machine. If the scaling on an instrument of this type be carefully examined it will be found to contract considerably in distance towards the end, so if the start of it or the "O" feet be moved from the correct point (which is "31" inches on the pressure scale) the value of it is all thrown off; that is, the indicating hand will be working in a part of the scale which should be more contracted in its divisions or vice versa.

Recording altitude barometers are being slowly but surely perfected. The manufacturers abroad are constructing on the experiences of aviators over there. The idea of a small cramped miniature article is sliding into oblivion, for those in a position to know realize that such instruments are useless. The Navy Department has in use instruments measuring about six inches in length and which record on a six-hour clock-drum to altitudes of 8,000 feet. They weigh but two pounds, which admits of a mechanism that can be depended upon for accuracy and stability and that will not "vibrate to pieces." As the length of the paper chart is about 8½ inches, the detail of the record can be studied with ease.

The test for indicating and recording aneroids is the same. The instrument is placed under a glass receiver in connection with a standard mercurial barometer. Before starting the test the instrument is made to agree with the mercury barometer as regards its reading.

The air is exhausted from the receiver, and due to the lessening pressure the aneroid mechanism operates, and the hand indicates at some point on the dial or chart. The mercury barometer changes also and gives the correct reading. If the aneroid under test does not agree with the mercury barometer a note is made of it and further tests carried on.

On getting the aneroid into "free" air again, certain parts of its mechanism can be adjusted to overcome the errors indicated under test, and it then again has to be tested. These tests are carried on until both instruments agree.

In my experience I have come to the conclusion that altitude instruments of all styles should be considered in the larger diameters, for, not only are they more accurate, but on account of the greater size all the adjustments, fittings, and delicate working parts can be made of length which admits of correct rating and allows the production of an instrument the results of which need never be criticized.

AIR LIFTS UNWATER A MINE

Air lifts were used at the mine of the Old Dominion Copper Mining & Smelting Co. at Globe, Arizona, in a recent emergency, when water flow increased on the upper levels of the mine and got beyond the pumping capacity of the plant. A 10-in. air lift raising the water 200 ft. (exclusive of friction), using air at 90 to 95 lbs. pressure at the power plant, required the following amount of air (measured by flow meter) at a barometric pressure of about 27 ins. of mercury.

Gals. Water per Minute.	Cu. Ft. Free Air per Minute.	Cu. Ft. Free Air per 1,000 Gal
1,011	1.353	1.338
1,680	1,809	1,080
1,794	2,262	1,261
1,925	2,658	1,375
1,965	3,219	1,638

Another lift raising water 431 ft. exclusive of friction gave the following results:

Gals. Water per Minute.	Cu. Ft. Free Air per Minute.		Cu. Ft. Free Air per 1,000 Gal.	
1,122	3,051		2.718	
1.233	3.306	3.395	2,681	2.753
1.233	3.484		2,825	
1,291	3.832	3.875	2.968	3.002
1,201	3.919		3.035	
1,325	4.089		3.086	

In these tests, which were kept up from 1 to 2 hours each, the measurements of air were taken with a General Electric Co. air-flow recording meter installed carefully and checked after test according to instructions furnished by the makers; the results are probably correct within 5%. The measurements on water were obtained by taking the reduction of speed of the pumps when air lift was working and the water level in sump kept constant and a volumetric efficiency of 90% assumed for the pumps. All pumps were equipped with revolution counters. The average speed of the pumps was recorded before and after the air test to insure that the water flow had not changed in the mine. The quantities of water are very nearly correct. The above figures are not given as absolute, but only to give a rough idea of what can be done with an air lift. In both cases the submergence was about 190 ft.

[The above, which we reproduce from *Mining and Engineering World,* is of value as embodying a reliable statement of actual results secured by the use of the air lift, which more than most devices requires the suggestions which experience alone can give. It will of course be understood that this was an emergency installation and that the best conditions for economical operation could not be insisted on. For instance, it will be noted that the actual submergence, 190 ft., was the same in both cases, this being about 49 per cent. where the lift was 200 ft. and only 30 per cent. for the higher lift. If the submergence in the first case had been, say, 55 per cent. and in the latter case 45 per cent., the proportional air consumption should have been less.]

The two national forests of Alaska contain about 78,000,000,000 ft. of merchantable timber and it is estimated by the Forest Service that 800,000,000 ft. could be cut every year forever without lessening the forests' productivity.

It might easily be supposed that disease germs are comparatively modern, the diseases themselves having been developed by the conditions that have obtained since man appeared on the earth. Dr. Charles D. Walcott, secretary of the Smithsonian Institution, has discovered fossil bacteria in very ancient limestone from Gallatin county, Mont. They are 20,000,000 or 30,000,000 years old and consist of individual cells and apparent chains of cells which correspond in appearance with the micrococci of to-day.

THE DRILLS.

By Berton Braley.

Hear the clamor of the drills
As they bark,
As they batter the foundations
Of the everlasting hills
In the dimly lighted dark,
And the loud reverberations
Fill the murky stopes with sound,
Waking echoes underground!

Oh, there's music to the drills,
And it thrills,
For the clamor as they hammer
And they batter on the rock
Is a song of brave endeavor
And of hope and progress too.
For the drills are drilling ever,
Making dreams come true!

Hear the ringing, swinging measure
Of the drills
As they dig for buried treasure
Underneath the mighty hills;
How they shout in joyous mirth
In the caverns of the earth!

How they clatter as they shatter
All the locks that guard the ore.
And their song grows ever louder
As they bore, bore, bore,
Making ready for the powder
Which shall wrench the rocks asunder
With a sound of muffled thunder,
With a deep and mighty roar.

In the deepest nooks and niches
Go the drills,
Reaching for the hidden riches
And the buried wealth that fills
Nature's treasure houses deep.
So the gold that misers heap,
And the silver and the lead
And the copper rich and red—
They are all the fruit of toiling
Of the drills;
They are plunder from the spoiling
Of the hills;

So the heart of man beats faster
And his every fiber thrills
To the song that makes him master
Of the treasure of the hills,
To the yammer and the hammer
And the wild barbaric clamor
And the unrelenting war song
Of the drills.

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JUST TO HELP THE NAVY

There be many things which all of us, and each individually, would have quite different if we could, but we have to take things as they are. Circumstances not of our making are crowding us as a nation and compelling sharp outlooking as to what may be before us. Violence and destruction are rampant and the thoughts of all true citizens in these times of unparalleled perplexity are necessarily turned to the nation's good right arm for the maintenance of its international status and for its sure defence if need be. We cannot think of ourselves alone, but must remember also our reciprocal duties in the brotherhood of nations, and for the fulfilment of these strength and armed equipment would seem to be essential.

Events unparalleled in history have been showing the world what a great navy might have done in the way of world wide devastation, and what a greater, stronger navy could do to circumvent it. Plans of world sweeping conquest were never so suddenly and so completely extinguished.

Geographical conditions, in view of the great outbreaking, urgently suggest to us that an efficient navy is our supreme national need, and this being conceded, for it is not our task to argue it, all practical means for devising and providing such an equipment should be diligently sought and honestly welcomed when found. The newly constituted Naval Consulting Board, and entirely regardless here of what it may ultimately accomplish, would seem at least to have common sense for its voucher. It may be assumed, if one be sufficiently optimistic, that in all essentials except magnitude, our existing navy, in organization, in personnel and in presumptive efficiency, is the equal of any, but, even so, nothing should be left undone which could contribute to its betterment.

Perhaps the most striking thing in connection with modern naval development is the rapidity with which ships and armament are successively superseded. For at least half a century it has happened continually that the latest, most confidently heralded products of the navy-yards of the world have in a single decade been regarded as obsolete and comparatively worthless, and the process of obsolence is perhaps more active and potent today than ever before, and none can tell what new and radical departure may date from the experiences of the present raging wars.

These things being so, there is call for every possible contribution of skill and experience wherever obtainable to guide in the design, construction, equipment and management of the navy of the future, and it is scarcely to be conceived that the group of men selected as the most advanced thinkers and workers in their respective lines, with the endorsement of individual success and accomplishment, cannot be of practical service to the nation in this connection.

The fighters of renown have never forged their own weapons. The world's fighting equipment to-day is invented and manufactured by non combatants, and presumption remains largely in favor of the civilian as the actual man behind the gun. The man who handles the guns has of course the final say as to the weapons provided.

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Steam Engineering and Ship Propulsion—Chairman, Andrew M. Hunt, William LeRoy Emmet, B. G. Lamme, Jos. W. Richards, M. B. Sellers.

Life Saving Appliances—Chairman, Spencer Miller, Hudson Maxim, Thomas Robins.

Aids to Navigation—Chairman, Elmer A. Sperry, Alfred Craven, A. M. Hunt, Henry A. Wise Wood, R. S. Woodward.

Food and Sanitation—Chairman, L. H. Backland, Hudson Maxim, Benjamin B. Thayer, W. R. Whitney, R. S. Woodward.

Public Works, Yards and Docks—Chairman, Alfred Craven, Lawrence Addicks, A. M. Hunt, Spencer Miller, Jos. W. Richards.

BRASHEAR DAY AT THE EXPOSITION

One of the most noteworthy of the doings at the Panama-Pacific International Exposition was the presentation of a special commemorative medal to Dr. John A. Brashear, as Pennsylvania's most notable citizen. We must tell of it all too briefly.

Colonel A. G. Hetherington, Director of Art, Pennsylvania Commission, presided, and in opening the proceedings said in part:

We are assembled here for the purpose of honoring a Pennsylvanian, who has been chosen as one of the most beloved, if not the most beloved, of the men of our state. He comes here representing nine millions of people. He has been honored all over the world, but the gewgaws that have been given to him are nothing, because he has, with his great genius, journeyed throughout the Heavens, with its illimitable space. He has within him the heart of a child and the agility of a boy, both physically and mentally.

Frank S. Brown, Director of the Exposition, presented the medal to Dr. Brashear, saying in part:

It is my great pleasure and high privilege to welcome here to-day Pennsylvania's most distinguished citizen, and to pay tribute to the genius of the man who has made not only his own state, but the nation illustrious.

Doctor Brashear is a man whom all the world honors for his accomplishments and above all for that sweet courtesy and kindliness of heart that has endeared him to his friends and to the people of Pennsylvania. When we consider his accomplishments and how he has made possible for those of us who walk on this earth to behold the wonders of the Heavens and to get our inspiration from the planets that are moving through infinite space, surely we can say that to Doctor Brashear may be applied George Eliot's attribute: "The world is but made better for his presence."

In behalf of the Board of Directors of this great Exposition, it is my high privilege to-day to present to Doctor Brashear this bronze medal, typifying as it does the efforts of the human race for more than four centuries in the development of the civilization on the western coast, the efforts of the people of the United States in the completion of the Panama Canal that made possible the linking of all the world together, the energies of the people of San Francisco in the rebuilding of their city, and last, but not least, the building of this magnificent Exposition, which commemorates the achievements of such men as Doctor Brashear and the men of the engineering profession, and so, Doctor, I ask that you accept in behalf of the President and Board of Directors of the Panama-Pacific International Exposition this bronze medal, carrying with it our love, our gratitude, and our appreciation of what you have done for this nation.

Doctor Brashear, in accepting the medal, said he could not conceive why the State of Pennsylvania had gone into the rolling mill and selected a mechanic as its leading citizen, when it had such men as Russell Conwell and John Wanamaker. He continued:

I must, however, say a few words of appreciation of the very kindly address that our good friend has given us in presenting me this medal. His words of praise are far more than I deserve, and far more than I shall be able to acknowledge in my response.

What I best love to say is that, although we may be great engineers, great scientific men or women, but whatever we are, it is our duty to have something else to do, as our good friend Mr. Brown has said, for the uplift and betterment of humanity, and the man or woman who cannot leave a record of having done something of the kind for the world, has lived in vain.

"It may be only a glad good morning
As we pass along the way,
But it will leave a ray of sunshine
Over the live-long day."

I want everybody to go from this place and forget me, but think of the other fellow, whom you can help out of the shadow into the sunlight of this old world. You can all do something. There is a greater accomplishment than that performed by our good friend Brown and his associates in the construction of these magnificent Exposition buildings—a greater work than we engineers and you officials have done in your calling—a greater work than the building of the Panama Canal, which has connected the two oceans. It is ours to break down the conditions that are damning this old world of ours by war, by affliction, by suffering, and by death. You and I can help to do it, everyone of us. Let us all, whether we get medals or not, do what we can to make this old round world run smoother on its bearings, by pouring the oil of joy upon them rather than the spirit of heaviness.

NEW BOOKS

Hydraulic Turbines, with a chapter on Centrifugal Pumps, by R. L. Dougherty. Second Edition, revised and enlarged. McGraw-Hill Book Company, New York. 200 pages, 6 by 9 in. 100 cuts and numerous tables, $2.00 (net).

This book embodies both theoretical and practical data bearing upon an important but highly specialized industry. A general idea is given of the conditions affecting turbine operation, the principles of construction and operation of modern turbines, the theory and characteristics of the principal types, commercial constants, means of selection of type and size, costs of turbine and other water power and comparisons with steam power. A valuable chapter is added on centrifugal pumps, with an appendix comprising full data from numerous actual tests. There is also a comprehensive series of review questions and problems.

Bulletin 98. Report of the Selby Smelter Commission, by J. A. Holmes, E. C. Franklin and R. A. Gould. 1915. Government Printing Office, Washington, D. C. 528 pages, 41 plates, 14 figures. Paper covers $1.25.

This voluminous publication embodies the results of elaborate and protracted investigation. It describes in detail the methods used, some of them new, in determining the contamination of the air and the damage to trees, crops and live stock by the smoke and fume from the Shelby Smelter in California, and gives the conclusions of the Commission on the methods used by the smelter company to prevent injury.

SAFETY IN STONE QUARRYING

The above is the title of a valuable paper (Technical Paper 111) by Oliver Bowles, recently issued by the Bureau of Mines and ready for free distribution. The Bureau, in connection with its work relating to the increase of safety in the mineral industries, is investigating quarries, and quarrying methods. This paper describes the results of an investigation of safety conditions in stone quarrying—more especially in the quarrying of marble. Its purpose is to point out the chief causes of accidents in stone quarries and to suggest preventive measures and devices. Many of the suggestions are applicable to all types of rock excavation, but relate chiefly to marble quarrying. Accident prevention is considered from three points of view—safety in equipment, safety in quarrying methods, and safety through proper care. The paper also describes methods of first aid in case of accident and includes a list of typical quarry accidents that have come to the writer's notice.

COMPRESSED AIR AS A DETECTOR OF SUBMARINES

It will be remembered that our issue for March of the present year contained an illustrated description of the Brasher Air Breakwater, which employs submerged pipes discharging compressed air up through the water, thus giving some elasticity to the waves and robbing them of their destructive force of impact. Mr. Brasher now suggests another possible application of his device which we present in his own words.

"Compressed air used in this way," writes Mr. Brasher, "would be the easiest and most satisfactory method of detecting enemy submarines that might try to penetrate any of our harbors or bases. If there is a line of perforated pipe across the channel or path through which the submarine must pass, and compressed air is forced through the pipe, there is an uninterrupted line of bubbles showing on the surface of the water. The minute that the submarine pokes its nose into this line of bubbles there will be a blank, smooth streak or break in the line of bubbles indicating exactly the spot where that submarine is crawling up the channel.

"I have spoken of this to a prominent officer of the General Staff, and he agrees with me that it could be made most valuable. He said that as soon as the position of the submarine was thus pointed out it would be a comparatively simple matter to destroy it, either by means of patrol boats or by contact mines. There is another feature, too, which should be considered, and that is that any submarine commander would hesitate to send his boat through a continuous screen such as would be formed by air liberated in this way, for it might suggest any kind of a trap directly behind it. My adviser seemed to think that it could be very easily demonstrated at Fortress Monroe."

NOVEL IMPROVEMENT IN STEAM DRIVEN COMPRESSORS

Present day steam engineering is marked by the wider use of high pressure and superheating. This condition has rendered unsatisfactory the use of the familiar slide valve gear, even of the adjustable cut-off type, for steam driven air compressors. The slide valve in various forms has long been standard on air compressing units below the sizes (about 24" stroke) where the Corliss valve becomes commercially practicable. At high temperatures the slide valve is quite objectionable on account of its tendency to warp, with consequent leakage. There is also increasing difficulty of lubrication which results in greater wear and a greater consumption of power in driving the valve.

To provide a steam driven compressor which will operate satisfactorily with high pressure and superheat, as well as at more moderate pressures, there has been developed and

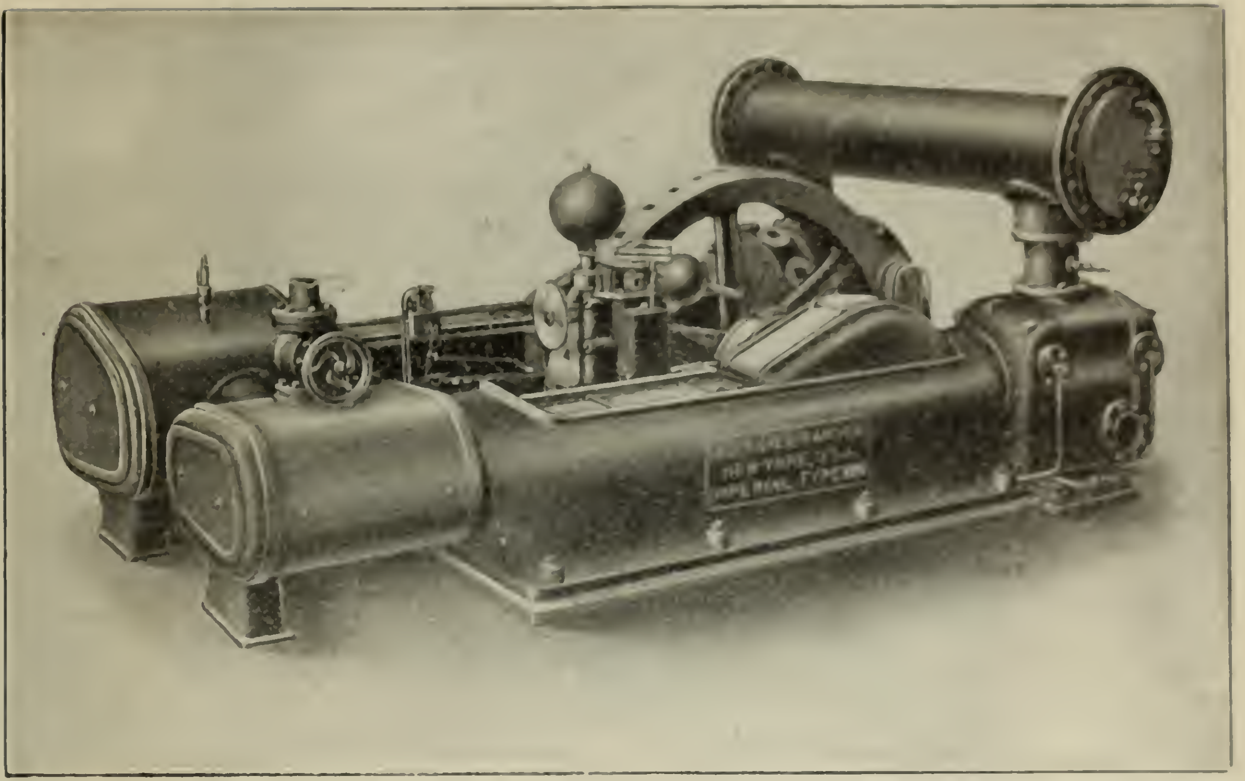


FIG. 1.- IMPERIAL COMPRESSOR. TYPE X P V.

perfected a Balanced Piston Steam Valve gear, which has been incorporated in the design of the standard "Imperial" Duplex Air Compressors.

The use of a balanced valve makes it possible to control the machine in the only really economical manner—by automatically varying the point of cut-off in the steam cylinders. This method of regulation maintains constant speed for changing steam pressures and also adjusts the speed of operation to the demand for air. Steam is admitted to the steam cylinder at full boiler pressure, and without the wire-drawing of a governor of the throttling type, which means that the machine automatically operates at its highest efficiency. It is pointed out that the higher the steam pressure the greater the relative increase in efficiency.

With the hand-adjusted cut-off valves usually set at $\frac{5}{8}$ or $\frac{3}{4}$ stroke, the steam economy is admittedly poor, while with an auto-

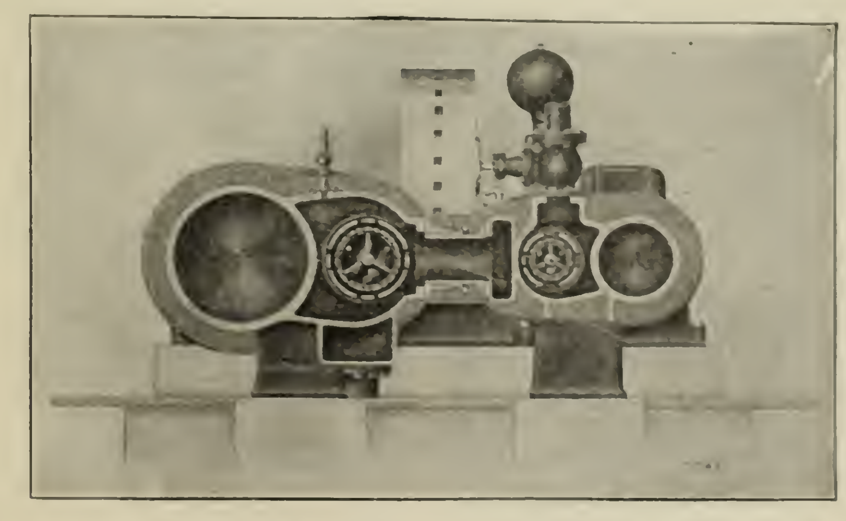


FIG. 2. VERTICAL CROSS SECTION.

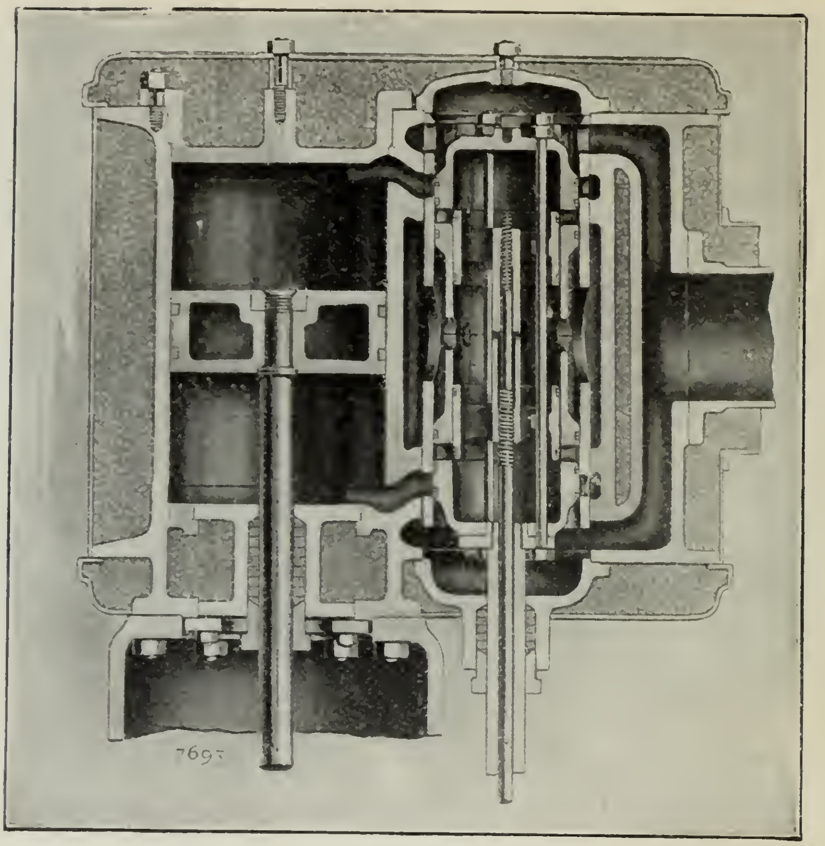


FIG. 3. PLAN IN SECTION.

matic cut-off regulation of wider range the saving in actual steam consumption is the point most emphasized by the manufacturer.

This piston valve is a perfectly balanced valve of the telescopic type. The cut-off valves are right and left hand threaded to a cut-off valve rod. Steam admission is through the center of the valve, the steam then passing through the valve ports to the cylinder and then being exhausted by the ends of the valve. It is to be noted that this construction exposes the valve chest covers and steam packings to exhaust pressure only, proportionately reducing the liability of leakage. The design and the even distribution of metal in the Imperial Piston valve are claimed to preclude any possibility of warping, and the valve is so balanced that friction is minimized and lubrication facilitated.

The steam ports are large and unusually direct. Exceptionally complete insulation, the separation of the live and the exhaust steam passages and the fact that the steam chest partially encircles the cylinder contribute to the steam economy. These points will be readily appreciated from the sectional illustration Fig. 3. The cylinder and receiver lagging is covered with a sheet iron casing and that of the cylinder heads with neatly fitting cast covers.

The unique steam receiver is a direct connection between high and low pressure steam chests. The low pressure chest is proportioned to furnish additional capacity and is so located that the heat ordinarily lost by radiation is used in heating the cylinder and valve. A special expansion joint prevents any possibility of cylinder alignment being impaired.

The governor is a speed and pressure regulator which varies the cut-off by automatically rotating the cut-off valve rod and changing the relative positions of the cut-off valves. It is essentially a chain driven rotary oil pump which acts against a weighted plunger. The variation in oil pressure due to the changing speed of the compressor, or the varying air pressure through the movement of the plunger, changes the cut-off point in the steam cylinders.

This governor is claimed to be entirely automatic in operation and capable of maintaining exceptionally reliable, as well as close, regulation.

Lubrication of both air and steam cylinders and valves is provided for by force feed oilers.

The other features of the new compressor, called by the maker "Imperial" Type XPV, are those of the "Imperials" now in service, wholly enclosed main frames containing the reciprocating parts, automatic lubrication by the bath system and the standard Imperial completely water jacketed air compressing cylinders.

This "Imperial" Type XPV compressor is a product of the Ingersoll-Rand Company, 11 Broadway, New York, and is built in capacities from 608 to 3,620 cubic feet per minute, and for discharge air pressures from 10 to 110 pounds per square inch.

NOTES

Of the fatal accidents which occur in Illinois coal mines, one half are caused by falls of roof and coal, and 18 per cent. by pit cars. Explosions are responsible for only 7 per cent. In the different districts of the State as a whole there are produced 170,478 tons of coal for each man killed and 24,194 tons for each one seriously injured.

The curious action of sea water upon steel under certain conditions is exemplified in the case of the half-a-million-dollar pleasure yacht Sea Call which after just six weeks of life on the ocean wave had to be broken up to prevent her sinking. It is understood that the plating was fastened to the steel frames without the interposition of zinc, which is said to be the successful practice in the navy.

In proportion to the numbers employed, more men are killed in the metal mines of the United States then in the coal mines. In the latter large numbers are sometimes killed at once, while in the metal mines single fatalities are of more frequent occurrence. For the three years 1911-1913, inclusive, the annual average of killed per thousand was 3.60 in coal mines and 4.08 in the various metal mines.

Ordinary blasting powder is not affected by the cold, but in warm damp weather it is liable to take up moisture and thus lose strength. It is made up largely of nitrate of soda with 10 to 15 per cent. sulphur and charcoal, and contains no liquid ingredient. Ordinary handling and shaking in transportation does not affect it. It is the nitrate of soda that attracts the moisture in the air.

It may be worth while next April to look again at the following mid-October item: "The old-time Indians of the Southwestern States are prophesying an usually long, cold winter. They say that the squirrels have already begun storing up goods, the bark on the trees is thicker than ordinarily, the summer has been abnormally cold and wet, the migration of birds started very early and numerous other signs which according to the aborigines never fail all go to forecast a winter of unusual severity."

When fuse is so stiff and brittle as to break open in being handled, its water resisting qualities are impaired. If fuse is allowed to become too old before it is used, there is danger that the varnishes will be dry and hard, or that the powder may become impaired by age, although such results are not liable to occur for several months, if the fuse is properly stored. Guttapercha fuses are the most liable to deterioration for the reason that guttapercha, rubber, and other vegetable matter of this nature, are subject to oxidation from contact with air.

Illium is the name given to a new acid-resisting alloy worked out at the University of Illinois, and described by S. W. Parr at the recent convention of the American Institute of Metals. Its composition is given as: Copper, 6.42 percent; Manganese, 0.98; Silicon, 1.04; Tungsten, 2.13; Nickel, 60.65; Aluminum, 1.09; Iron, 0.76; Chromium, 21.07; Molybdenum, 4.67; total 98.81 per cent; Carbon and Boron not determined. It is said to be entirely resistant to 25 per cent. nitric acid. Its properties are ascribed to a proper proportioning of electro-positive and negative metals.

LATEST U. S. PATENTS

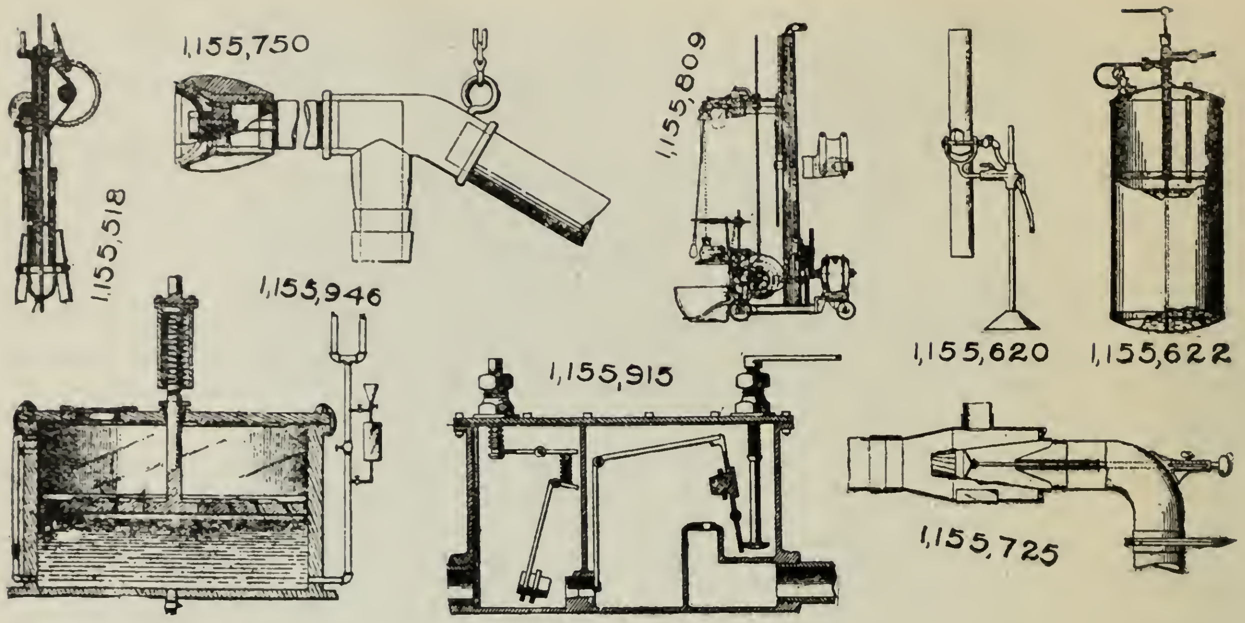
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 5.

1,155,518. WINDMILL. Daniel R. Scholes, Chicago, Ill.

1,155,530. PROCESS FOR FINISHING BREAD AND THE LIKE. Arnold S. Wahl, Chicago, Ill.

3. The herein described process of finishing bread and the like, which consists in surrounding the same while cooling, after baking, with an atmosphere free from oxygen.



Pneumatic Patents October 5.

4. The herein described process of finishing bread and the like, which consists in surrounding the same while cooling, after baking, with an atmosphere of carbon dioxid.

1,155,571. PNEUMATIC ACTION FOR PLAYER-PIANOS. Otto Higel, Toronto, Canada.

1,155,594. COMPRESSED-AIR HYDRAULIC PUMP. Attilio Mariotti, Florence, Italy.

1,155,620. AIR-INJECTOR. Wenzel Scheick, Waterbury, Conn.

1,155,622. PRESSURE-TANK FOR VAPOR-LAMP SYSTEMS. Edward Seitz, Peoria, Ill.

1,155,725. AIR-FEED FOR PULVERIZED FUEL. Simon Henry Harrison, Easton, Pa.

1,155,750. TUBE-BLOWER. Eugene J. McCarty, Clinton, Mass.

1,155,809. GLASS-BLOWING MACHINE. Noble W. Hartman, Toledo, Ohio.

1,155 915. AUTOMATIC FLUID-PRESSURE CUT-OFF. Martin L. Grove, Tylersburg, Pa.

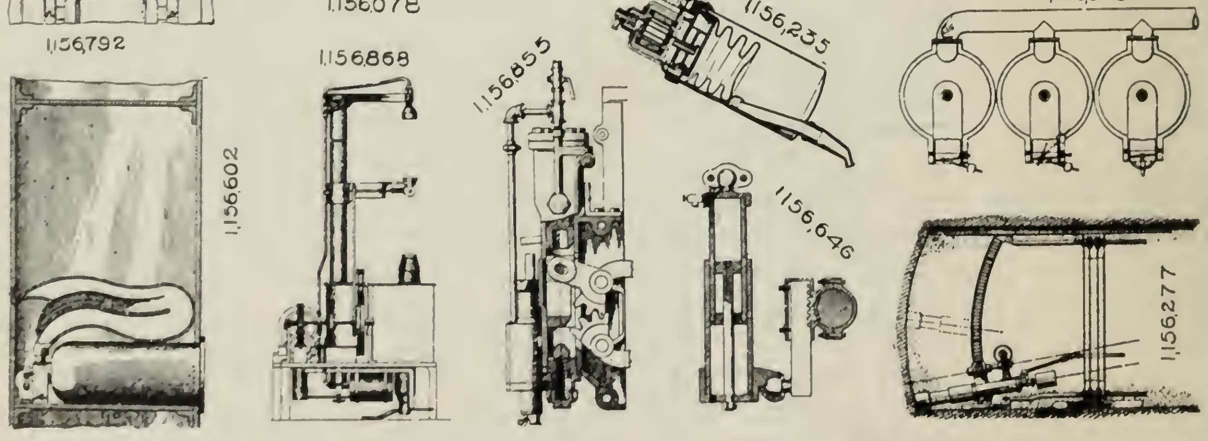
1,155,946. COMBINED VACUUM WASHING AND WRINGING MACHINE. Shrewsbury B. Miller, Fairmont, W. Va.

OCTOBER 12.

1,156,056-7-8. MOLD MECHANISM FOR GLASS-BLOWING MACHINES. Benjamin Day Chamberlin, Corning, N. Y.

1,156,078. AIR-VENDING MACHINE. Arthur Peart Holden and Robert James Copeland, Toronto, Ontario, Canada.

1,156,118. CENTRIFUGAL FAN. Robert Warg, Milwaukee, Wis.



Pneumatic Patents October 12.

1,156,196. PNEUMATIC SEED AND DUST CONVEYER FOR COTTON-GINS. Silas Willis, Noble, Okla.

1,156,235. HANDHOLD VACUUM-CLEANER. James B. Kirby, Cleveland, Ohio.

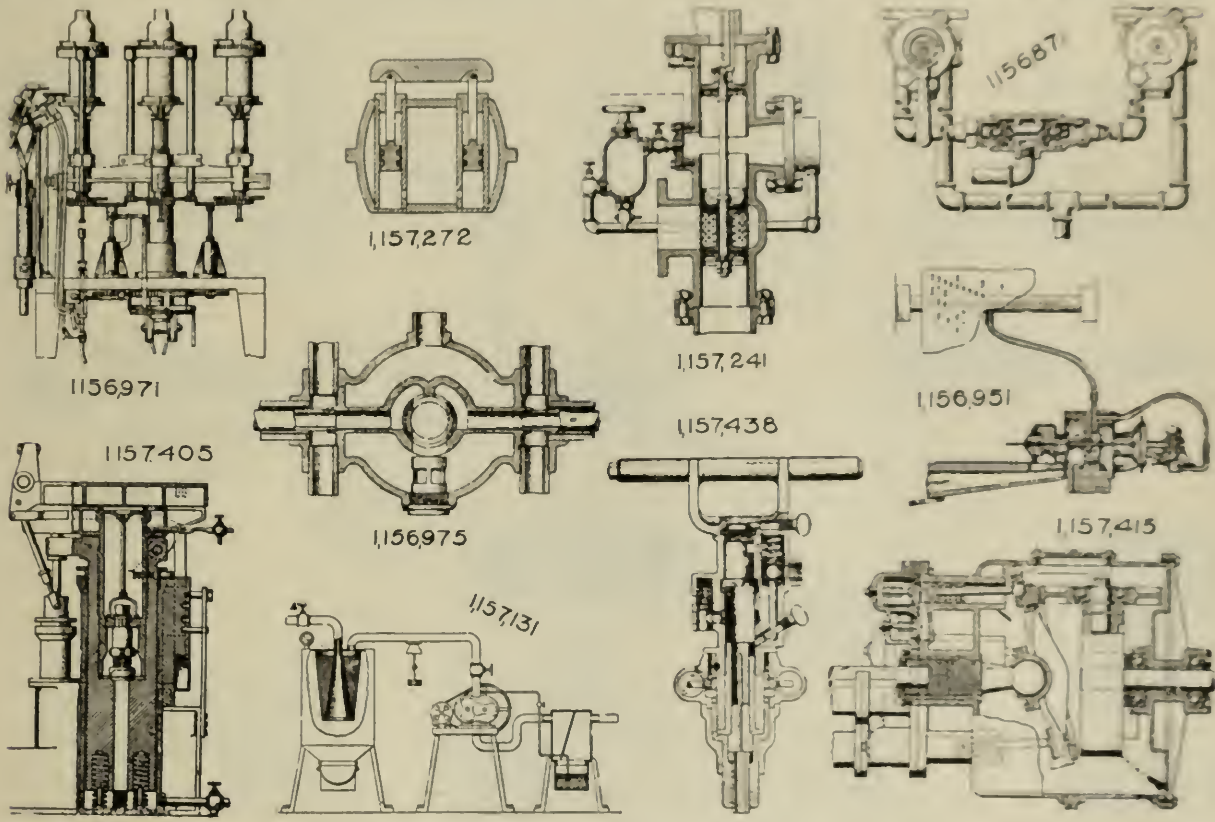
1,156,278. VACUUM-HORSESHOE. James M. Dove, Chicago, Ill.

1,156,277. TUNNELING-MACHINE. William E. Dean, Superior, Wis.

1,156,602. COMPARTMENT-INFLATER FOR SHIPS. Morris Kasser and Joseph B. Kasser, San Francisco, Cal.

1,156,613. CENTRIFUGAL COMPRESSOR. Sanford A. Moss, Lynn, Mass.

1,156,646. SHOCK-ABSORBER. Raymond R. Walker, Follansbee, W. Va.



Pneumatic Patents October 19.

1,156,660. METHOD AND APPARATUS FOR MEASURING THE FLOW OF FLUIDS. Ernst J. Berg, Schenectady, N. Y.

1. The method of measuring the flow of steam, air and other fluids, which comprises determining the amount of energy required to maintain at a constant temperature a body upon which said fluid exerts a cooling action as it flows.

1,156,792. PNEUMATIC CONTROL OF INFLOWING WATER IN DAMAGED SHIPS. Arthur Richard McAvoy, Collie, Western Australia, Australia.

1,156,855. FLUID-ACTUATED MOTOR. George Akans, Atlanta, Ga.

1,156,868. GLASS-BLOWING MACHINE. Vernon M. Dorsey, Laurel Grove, Md.

OCTOBER 19.

1,156,871. BRAKE-VALVE DEVICE. Burton S. Aikman, Milwaukee, Wis.

1,156,874. SUCTION-CLEANER. Edward M. Barnes, Hastings, Mich.

1,156,951. PNEUMATIC PIANO-PLAYER. Eugene C. Wamelink, Cleveland, Ohio.

1. In a piano player, a tracker board, a chest, a power pneumatic for each note, valve mechanism for controlling each power pneumatic, motor means for actuating said valve mechanism, and a single governing device actuated by outside air for controlling the operation of the motor means.

1,156,971. MACHINE FOR THE MANUFACTURE OF VACUUM-RECEPTACLES. William R. Burrows, Newark, N. J.

1,156,975. DEVICE FOR MIXING GASES. Albert Charles Clark, Chicago, Ill.

1,157,131. METHOD OF CLEANING SCREENS OF VACUUM CLEANING APPARATUS. William S. Sutton, Rockford, Ill.

The method of cleaning the screen in the separator of a vacuum cleaning apparatus which consists in sealing the air intake, exhausting the air from said separator, discontinuing said exhausting operation and sealing said separator, and then causing a series of sudden inrushes of air, at atmospheric pressure, to enter said separator in a direction opposite to that of the flow of air during said exhausting operation whereby to produce a series of pulsations of compression shocks within said separator acting upon said screen to dislodge solid matter adhering thereto, substantially as specified.

1,157,144. AUTOMATIC TRAIN-STOPPING MECHANISM. Werner Beutel, Bridgeport, Conn.

1,157,216. AUTOMATIC AIR-EXHAUST FOR CENTRIFUGAL PUMPS. Carl E. Grunsky, San Francisco, Cal.

1,157,241. LUBRICATING SYSTEM. Harry C. Martin, Philadelphia, Pa.

1,157,272. RESILIENT WHEEL. Charles A. Whale and James H. Black, Portland, Oreg.

1,157,398. PNEUMATIC ACTION. Charles J. Johnson, Chicago, Ill.

1,157,403-4-5-6. MOLDING-MACHINE. Wilfred Lewis, Philadelphia, Pa.

1,157,415. FLUID - POWER - TRANSMITTING APPARATUS FOR VEHICLES. Horatio N. Norton, Mount Vernon, N. Y.

1,157,430. PNEUMATIC TOOL. Mather W. Sherwood, Franklin, Pa.

1,157,456. VACUUM-CLEANER. James H. Taylor, Toledo, Ohio.

OCTOBER 26.

1,157,682. LOADING APPARATUS OF HEAVY GUNS. Arthur Trevor Dawson, Westminster, London, and James Horne, Barrow-in-Furness, England.

1. In gun loading apparatus the combination with the slide frame, the rammer actuating motor carried thereby, and the motor control hand lever mounted on a part of the mounting that does not move in elevation, of a control valve carried by the slide frame, and pressure fluid means for actuating said valve from the aforesaid hand lever.

1,157,703. WET VACUUM-PUMP OF THE ROTARY TYPE. Maurice Leblanc, Val-sur-Seine, Croissy, France.

1,157,723. APPARATUS FOR CONTROLLING RAILWAY-TRAINS. Joseph O. Query, Somerville, Mass.

1,157,859. OZONE-GENERATOR. William O. Freet, Hackensack, N. J.

1,157,922. WATER-POWER PLANT. Elmer Bassett, Shelbyville, Ind.

1. In a water power plant, the combination with a water wheel, of pneumatic pistons and cylinders for raising and lowering said wheel, a pump for supplying compressed air to said pistons, an electric motor for driving said pump and an electric generator for supplying current to said motor driven from said wheel.

1,157,924. PNEUMATIC TOOL. Charles Christiansen, Gelsenkirchen, Germany.

1,157,954. AIR-RETAINING VALVE FOR AIR-BRAKE APPARATUS. Spencer G. Neal, Los Angeles, Cal.

1,157,957. FLUID-PRESSURE REGULATOR. Arnold Pfau, Milwaukee, Wis.

1,157,959. ART OR PROCESS OF LIQUEFYING AIR AND SEPARATING THE SAME INTO OXYGEN AND NITROGEN. James F. Place, Glen Ridge, N. J.

1. The process of liquefying atmospheric air, which consists in compressing the air, cooling the same, and liquefying a part of one portion thereof and expanding with production of recoverable external work the unliquefied gaseous residue of such portion along with the other portion; and finally partially releasing from pressure the liquid thus obtained and sub-cooling therewith the unreleased liquid.

1,157,998. AIR-LIFT-PUMP BOOSTER. Frank S. Miller, Indianapolis, Ind.

1. In combination, a closed chamber, a pipe leading from a well into such chamber and opening into said chamber above the liquid level therein, an air nozzle in such pipe below such chamber, a pipe leading from such chamber and opening into such chamber below the liquid level therein, a downwardly opening hood located in said chamber and having its open lower end below the liquid level therein, said first named pipe discharging upwardly into said chamber and said last named pipe opening under said hood, and an automatic air valve controlling the outlet of air from and maintaining a pressure greater than atmosphere in said chamber.

1,158,029. FLUID-PRESSURE DEVICE. Christian Dantsizen, Schenectady, N. Y.

1. The combination of a cylinder, a piston therein arranged to be urged in a given direction, a conduit for delivering a fluid under pressure to a chamber of said cylinder to urge said piston in the opposite direction, a conduit for discharging said fluid, and means for varying at will the ratio of delivery of said fluid with respect to the discharge thereby varying the position of the piston in said cylinder.

1,158,030. COMPRESSOR. Heinrich Deschamps, Charlottenburg, Germany.

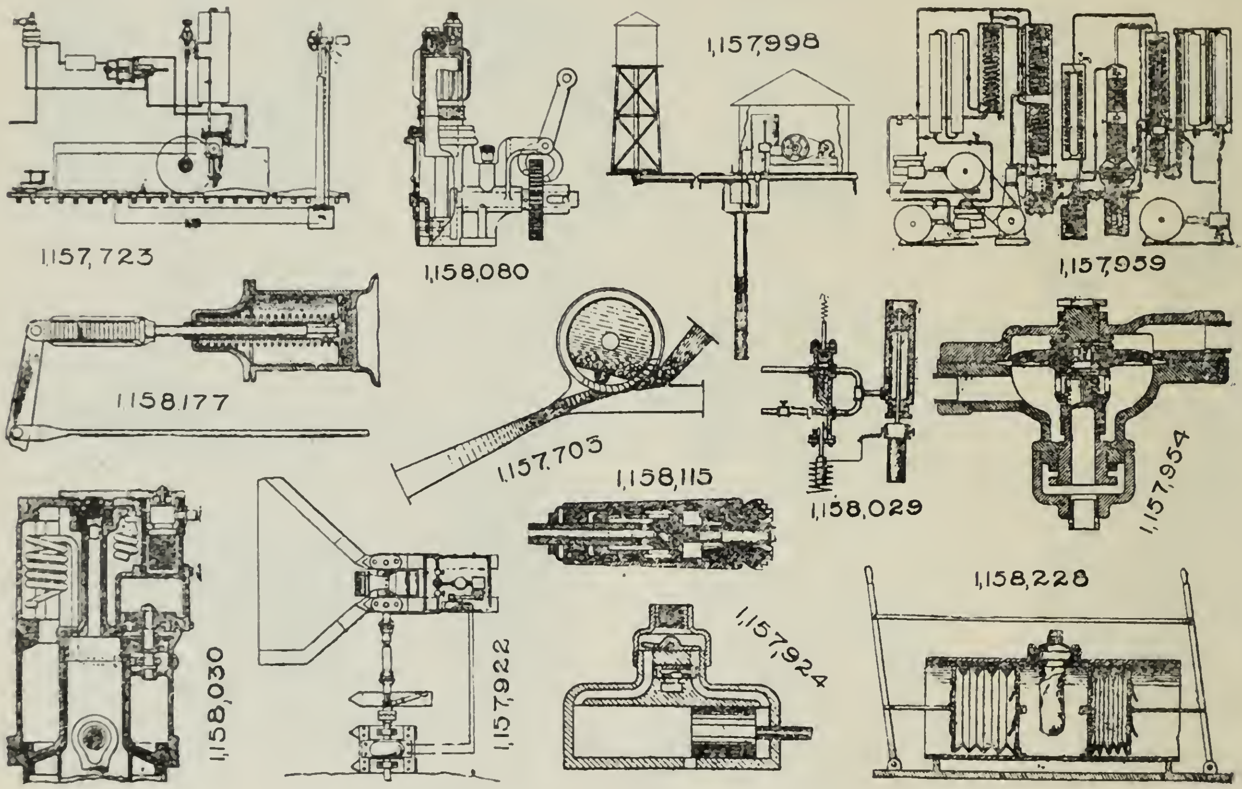
1,158,067. PNEUMATIC ACTION FOR PIANO-PLAYERS. Nels Magnuson, Fort Wayne, Ind.

1,158,080. AIR-PUMP. John K. Stewart, Chicago, Ill.

1,158,115. PERCUSSIVE TOOL FOR SCALING TUBES. Harry Samuel Bickerton Brindley, London, England.

1,158,177. SLACK TAKE-UP FOR FLUID-PRESSURE-BRAKE SYSTEMS. George Christenson, Jamaica, N. Y.

1,158,228. PUMPING MECHANISM. Lawrence S. Kaskie, Rock Valley, Iowa.



Pneumatic Patents October 26.

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